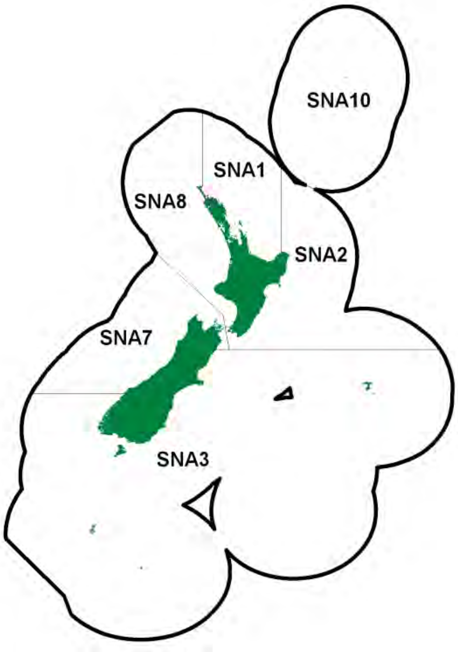
INTRODUCTION – SNAPPER (SNA)

(*Chrysophrys auratus*)
Tamure, Kouarea



1. INTRODUCTION

Specific Working Group reports, describing/including stock assessments, are given separately for SNA 1, SNA 2, SNA 7 and SNA 8. The TACC for SNA 3 and SNA 10 are 32 t and 10 t respectively, with minimal annual landings (less than 1 t or zero t in most years) reported from these stocks.

1.1 Commercial fisheries

Snapper fisheries are one of the largest and most valuable coastal fisheries in New Zealand. The commercial fisheries, which began their development in the late 1800s, expanded in the 1970s with increased catches by trawl and Danish seine. Following the introduction of pair trawling in most areas, landings peaked in 1978 at 17 500 t (Table 1). Pair trawling was the dominant method, accounting for on average 75% of the annual SNA 8 catch from 1976 to 1989. In the 1980s an increasing proportion of the SNA 1 catch was taken by longlining as the Japanese "iki jime" market was developed. By the mid-1980s catches had declined to 8500–9000 t, and some stocks showed signs of overfishing. The fisheries had become more dependent on the recruiting year classes as stock size decreased. With the introduction of the QMS in 1986, TACCs in all Fishstocks were set at levels intended to allow for some stock rebuilding. Decisions by the Quota Appeal Authority saw TACCs increase to over 6000 t for SNA 1 by the fishing year 1990–91, and from 1330 t to 1594 t for SNA 8 by 1989–90 (Table 2).

In 1986–87, landings from the two largest Fishstocks (i.e., SNA 1 and SNA 8) were less than their respective TACCs (Table 2) but catches subsequently increased in 1987–88 to the level of the TACCs (Figure 1). Landings from SNA 7 remained below the TACC after introduction to the QMS, and in 1989–90 the TACC was reduced to 160 t. Changes to TACCs that took effect from 1 October 1992 resulted in a reduction for SNA 1 from 6010 t to 4938 t, an increase for SNA 2 from 157 t to 252 t, and a reduction for SNA 8 from 1594 t to 1500 t.

Table 1: Reported landings (t) for the main QMAs from 1931 to 1990.

Year	SNA 1	SNA 2	SNA 7	SNA 8	Year	SNA 1	SNA 2	SNA 7	SNA 8
1931–32	3 355	0	69	140	1961	5 887	589	583	1 178
1932–33	3 415	0	36	159	1962	6 502	604	582	1 352
1933–34	3 909	21	65	213	1963	6 967	636	569	1 456
1934–35	4 317	168	7	190	1964	7 269	667	574	1 276
1935–36	5 387	149	10	108	1965	7 991	605	780	1 182
1936–37	6 369	78	194	103	1966	8 762	744	1 356	1 831
1937–38	5 665	114	188	85	1967	9 244	856	1 613	1 477
1938–39	6 145	122	149	89	1968	10 328	765	1 037	1 491
1939–40	5 918	100	158	71	1969	11 318	837	549	1 344
1940–41	5 100	103	174	76	1970	12 127	804	626	1 588
1941–42	4 791	148	128	62	1971	12 709	861	640	1 852
1942–43	4 096	74	65	57	1972	11 291	878	767	1 961
1943–44	4 456	60	29	75	1973	10 450	798	1 258	3 038
1944	4 909	49	96	69	1974	8 769	716	1 026	4 340
1945	4 786	59	118	124	1975	6 774	732	789	4 217
1946	5 150	77	232	244	1976	7 743	732	1 040	5 326
1947	5 561	36	475	251	1977	7 674	374	714	3 941
1948	6 469	53	544	215	1978	9 926	454	2 720	4 340
1949	5 655	215	477	277	1979	10 273	662	1 776	3 464
1950	4 945	285	514	318	1980	7 274	636	732	3 309
1951	4 173	265	574	364	1981	7 714	283	592	3 153
1952	3 665	220	563	361	1982	7 089	160	591	2 636
1953	3 581	247	474	1 124	1983	6 539	160	544	1 814
1954	4 180	293	391	1 093	1984	6 898	227	340	1 536
1955	4 323	309	504	1 202	1985	5 876	208	270	1 866
1956	4 615	365	822	1 163	1986	5 969	255	253	959
1957	5 129	452	1 055	1 472	1987	4 016	122	210	1 072
1958	5 007	483	721	1 128	1988	5 038	165	193	1 565
1959	5 607	372	650	1 114	1989	5 754	227	292	1 571
1960	5 889	487	573	1 202	1990	5 826	429	200	1 551

Notes:
1. The 1931–1943 years are April–March but from 1944 onwards are calendar years.
2. The ‘QMA totals’ are approximations derived from port landing subtotals, as follows: SNA 1, Mangonui to Whakatane; SNA 2 Gisborne to Wellington/Makara; SNA 7, Marlborough Sounds ports to Greymouth; SNA 8 Paraparaumu to Hokianga.
3. Before 1946 the ‘QMA’ subtotals sum to less than the New Zealand total because data from the complete set of ports are not available. Subsequent minor differences result from small landings in SNA 3, not listed here.
4. Data up to 1985 are from fishing returns: data from 1986 to 1990 are from Quota Management Reports.
5. 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 include both foreign and domestic landings.

Table 2: Reported landings (t) of snapper by Fishstock from 1983–84 to present and gazetted and actual TACCs (t) for 1986–87 to present. QMS data from 1986–present. [Continued on next page]

Fishstock	SNA 1		SNA 2		SNA 3		SNA 7		SNA 8	
FMAs	1		2		3, 4, 5, 6		7		8, 9	
	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC
1983–84†	6 539	–	145	–	2	–	375	–	1 725	–
1984–85†	6 898	–	163	–	2	–	255	–	1 546	–
1985–86†	5 876	–	177	–	0	–	188	–	1 828	–
1986–87	4 016	4 710	130	130	< 1	32	257	330	893	1 331
1987–88	5 038	5 098	152	137	1	32	256	363	1 401	1 383
1988–89	5 754	5 614	210	157	< 1	32	176	372	1 527	1 508
1989–90	5 826	5 981	364	157	< 1	32	294	151	1 551	1 594
1990–91	5 273	6 002	428	157	< 1	32	160	160	1 659	1 594
1991–92	6 176	6 010	373	157	< 1	32	148	160	1 459	1 594
1992–93	5 427	4 938	324	252	< 1	32	165	160	1 543	1 500
1993–94	4 847	4 938	307	252	< 1	32	147	160	1 542	1 500
1994–95	4 857	4 938	308	252	< 1	32	150	160	1 436	1 500
1995–96	4 938	4 938	280	252	< 1	32	146	160	1 558	1 500
1996–97	5 047	4 938	351	252	< 1	32	162	160	1 613	1 500
1997–98	4 525	4 500	286	252	< 1	32	182	200	1 589	1 500
1998–99	4 412	4 500	283	252	2	32	142	200	1 636	1 500
1999–00	4 509	4 500	390	252	< 1	32	174	200	1 604	1 500
2000–01	4 347	4 500	360	252	< 1	32	156	200	1 631	1 500
2001–02	4 374	4 500	252	252	1	32	141	200	1 577	1 500
2002–03	4 487	4 500	334	315	< 1	32	187	200	1 558	1 500
2003–04	4 469	4 500	339	315	< 1	32	215	200	1 667	1 500
2004–05	4 641	4 500	399	315	< 1	32	178	200	1 663	1 500
2005–06	4 539	4 500	389	315	< 1	32	166	200	1 434	1 300
2006–07	4 429	4 500	329	315	< 1	32	248	200	1 327	1 300
2007–08	4 548	4 500	328	315	< 1	32	187	200	1 304	1 300
2008–09	4 543	4 500	307	315	< 1	32	205	200	1 345	1 300
2009–10	4 465	4 500	296	315	< 1	32	188	200	1 280	1 300
2010–11	4 516	4 500	320	315	< 1	32	206	200	1 313	1 300
2011–12	4 614	4 500	358	315	< 1	32	216	200	1 360	1 300

Table 2 [Continued]:

Fishstock	SNA 1		SNA 2		SNA 3		SNA 7		SNA 8	
FMAs	1		2		3, 4, 5, 6		7		8, 9	
	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC
2012–13	4 457	4 500	310	315	< 1	32	211	200	1 331	1 300
2013–14	4 459	4 500	313	315	< 1	32	210	200	1 275	1 300
2014–15	4 479	4 500	271	315	< 1	32	210	200	1 272	1 300
2015–16	4 408	4 500	321	315	< 1	32	189	200	1 328	1 300
2016–17	4 620	4 500	373	315	< 1	32	263	250	1 334	1 300
2017–18	4 567	4 500	373	315	< 1	32	263	250	1 288	1 300
2018–19	4 437	4 500	364	315	< 1	32	257	250	1 293	1 300
2019–20	4 460	4 500	330	315	< 1	32	289	250	1 347	1 300
2020–21	4 579	4 500	321	315	< 1	32	337	350	1 295	1 300
2021–22	4 296	4 500	337	315	< 1	32	361	350	1 720	1 600
2022–23	4 474	4 500	339	315	< 1	32	518	450	1 728	1 600

Fishstock	SNA 10			
QMAs	10		Total	
	Landings	TACC	Landings§	TACC
1983–84†	0	–	9 153	–
1984–85†	0	–	9 228	–
1985–86†	0	–	8 653	–
1986–87	0	10	5 314	6 540
1987–88	0	10	6 900	7 021
1988–89	0	10	7 706	7 691
1989–90	0	10	8 034	7 932
1990–91	0	10	7 570	7 944
1991–92	0	10	8 176	7 962
1992–93	0	10	7 448	6 858
1993–94	0	10	6 842	6 883
1994–95	0	10	6 723	6 893
1995–96	0	10	6 924	6 893
1996–97	0	10	7 176	6 893
1997–98	0	10	6 583	6 494
1998–99	0	10	6 475	6 494
1999–00	0	10	6 669	6 494
2000–01	0	10	6 496	6 494
2001–02	0	10	6 342	6 494
2002–03	0	10	6 563	6 557
2003–04	0	10	6 686	6 557
2004–05	0	10	6 881	6 557
2005–06	0	10	6 527	6 357
2006–07	0	10	6 328	6 357
2007–08	0	10	6 367	6 357
2008–09	0	10	6 399	6 357
2009–10	0	10	6 230	6 357
2010–11	0	10	6 355	6 357
2011–12	0	10	6 547	6 357
2012–13	0	10	6 309	6 357
2013–14	0	10	6 256	6 357
2014–15	0	10	6 232	6 357
2015–16	0	10	6 247	6 357
2016–17	0	10	6 590	6 407
2017–18	0	10	6 490	6 407
2018–19	0	10	6 351	6 407
2019–20	0	10	6 425	6 407
2020–21	0	10	6 532	6 507
2021–22	0	10	6 714	6 807
2022–23	0	10	7 059	6 907

† FSU data. SNA 1 = Statistical Areas 001–010; SNA 2 = Statistical Areas 011–016; SNA 3 = Statistical Areas 018–032; SNA 7 = Statistical Areas 017, 033–036, 038; SNA 8 = Statistical Areas 037, 039–048.

From 1 October 1997 the TACC for SNA 1 was reduced to 4500 t, within an overall TAC of 7550 t, and the TACC for SNA 7 was increased to 200 t within an overall TAC of 306 t. In SNA 2, the bycatch of snapper in the tarakihi, red gurnard, and other fisheries resulted in overruns of the snapper TACC in all years from 1987–88 up to 2000–01. From 1 October 2002, the TACC for SNA 2 was increased from 252 t to 315 t, within a total TAC of 450 t. Nevertheless the 315 t TACC has regularly been over-caught since, except in the fishing years 2008–09 to 2009–10 and 2012–13 to 2014–15. In 2016–17, the TAC for SNA 7 was increased from 306 t to 545 t, including an increase in the TACC from 200 t to 250 t. The SNA 7 TACC was increased again in 2020–21 to 350 t. From 1 October 2005 the TACC for SNA 8 was reduced to 1300 t within a TAC of 1785 t, and later increased from 2021 to 1600 t within a TAC of 3065 t following a rebuild of the stock. Table 3 shows the TACs, TACCs, and allowances for each

Fishstock from 1 October 2020. All commercial fisheries have a minimum legal size (MLS) for snapper of 25 cm.

Table 3: TACs, TACCs, and allowances (t) for snapper by Fishstock from 1 October 2020.

Fishstock	TAC	TACC	Customary allowance	Recreational allowance	Other mortality
SNA 1	8 050	4 500	50	3 050	450
SNA 2	450	315	14	90	31
SNA 3		32	–	–	–
SNA 7	645	350	20	250	25
SNA 8	3 065	1 600	100	1 205	160
SNA 10		10	–	–	–

Foreign fishing

Japanese catch records and observations made by New Zealand naval vessels indicate that significant quantities of snapper were taken from New Zealand waters by Japanese vessels from the late 1950s until 1977. There are insufficient data to quantify historical Japanese catch tonnages for the respective snapper stocks. However, trawl catches have been reported by area from 1967 to 1977, and longline catches from 1975 to 1977 (Table 4). These data were supplied to the Fisheries Research Division of MAF in the late 1970s; however, the data series is incomplete, particularly for longline catches.

Table 4: Reported landings (t) of snapper from 1967 to 1977 by Japanese trawl and longline fisheries. These landings are included in Table 1.

Year	(a) Trawl	Trawl catch (all species)	Total snapper trawl catch	SNA 1	SNA 7	SNA 8
1967		3092	30	NA	NA	NA
1968		19 721	562	1	17	309
1969		25 997	1 289	–	251	929
1970		31 789	676	2	131	543
1971		42 212	522	5	115	403
1972		49 133	1 444	1	225	1 217
1973		45 601	616	–	117	466
1974		52 275	472	–	98	363
1975		55 288	922	26	85	735
1976		133 400	970	NA	NA	676
1977		214 900	856	NA	NA	708
Year	**(b) Longline**		**Total Snapper**	**SNA 1**	**SNA 7**	**SNA 8**
1975			1 510	761	–	749
1976			2 057	930	–	1 127
1977			2 208	1 104	–	1 104

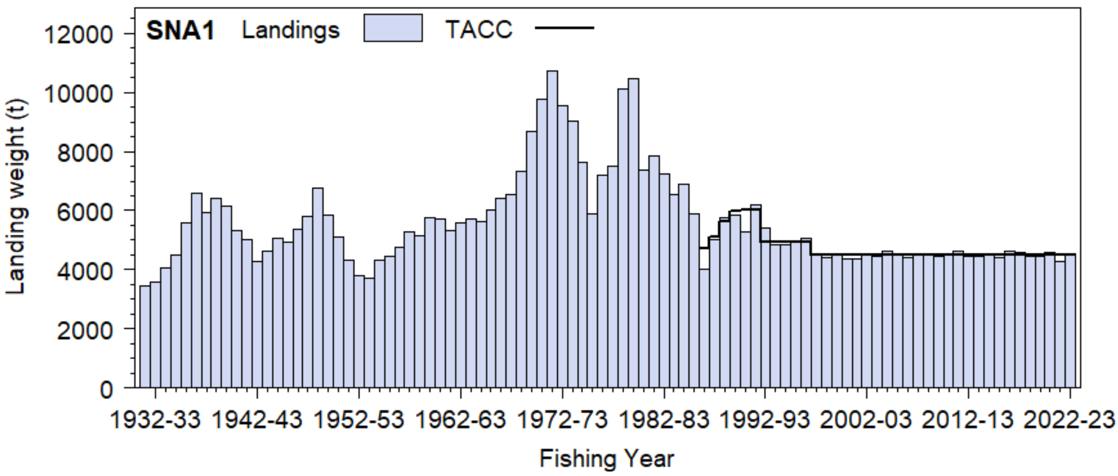


Figure 1: Total reported landings and TACCs for the four main SNA stocks. SNA 1 (Central East). [Continued on next page]

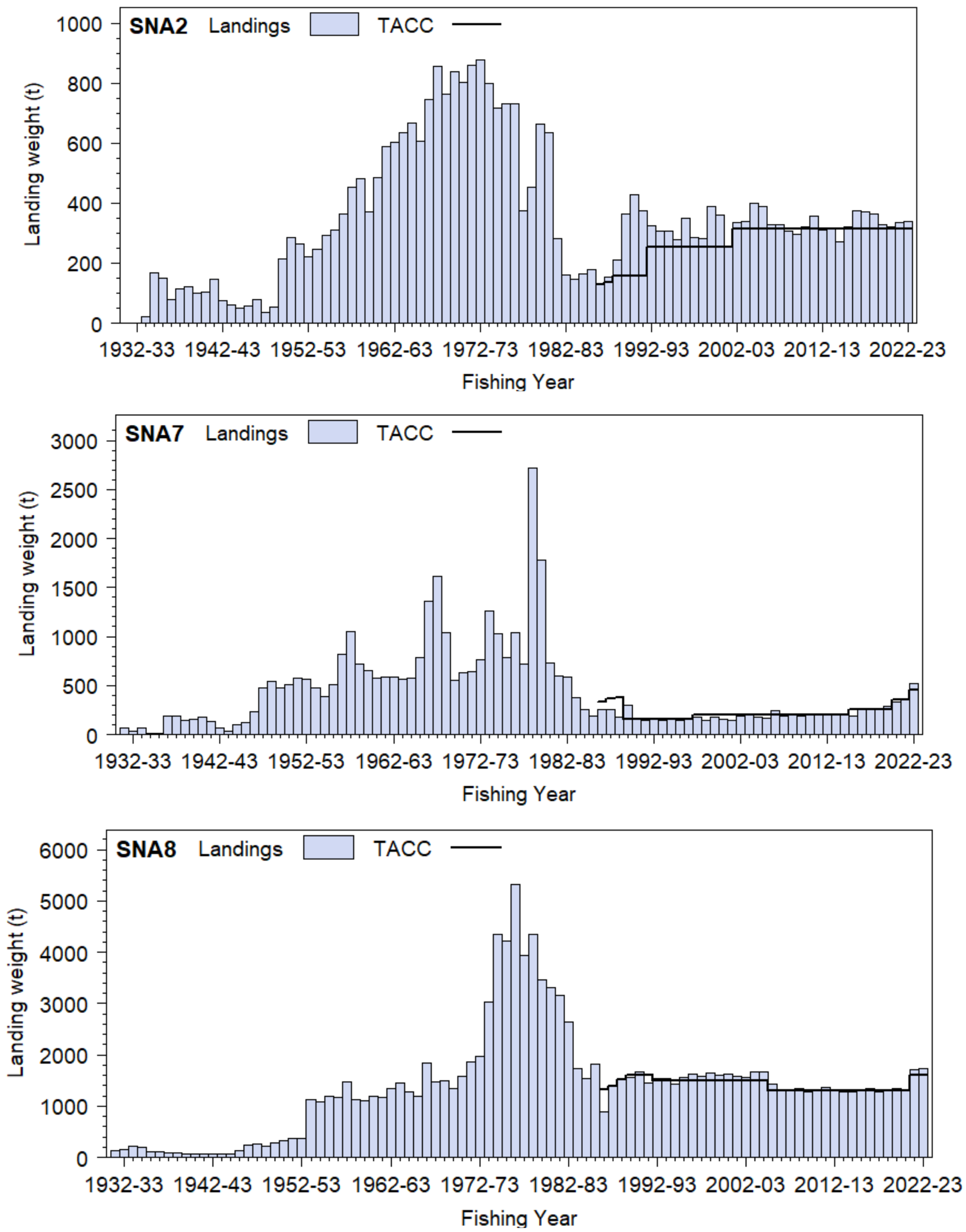


Figure 1 [Continued]: Total reported landings and TACC for the four main SNA stocks. SNA 2 (Central East) and SNA 7 (Challenger) and SNA 8 (Central Egmont).

1.2 Recreational fisheries

The snapper fishery is the largest recreational fishery in New Zealand. It is the major target species on the northeast and northwest coasts of the North Island and is targeted seasonally around the rest of the North Island and the top of the South Island. The current allowances within the TAC for each Fishstock are shown in Table 3.

1.2.1 Management controls

The two main methods used to manage recreational harvests of snapper are minimum legal size limits (MLS) and daily bag limits. Both have changed over time (Table 5). The number of hooks permitted on a recreational longline was reduced from 50 to 25 in 1995.

Table 5: Changes to minimum legal size limits (MLS) and daily bag limits used to manage recreational harvesting levels in snapper stocks, 1985–2014.

Stock	MLS	Bag limit	Introduced
SNA 1	25	30	1/01/1985
SNA 1	25	20	30/09/1993
SNA 1	27	15	1/10/1994
SNA 1	27	9	13/10/1995
SNA 1	30	7	1/04/2014
SNA 2	25	30	1/01/1985
SNA 2	27	10	1/10/2005
SNA 3	25	30	1/01/1985
SNA 3	25	10	1/10/2005
SNA 7	25	30	1/01/1985
SNA 7 (excl Marlborough Sounds)	25	10	1/10/2005
SNA 7 (Marlborough Sounds)	25	3	1/10/2005
SNA 8	25	30	1/01/1985
SNA 8 (FMA 9 only)	25	20	30/09/1993
SNA 8 (FMA 9 only)	27	15	1/10/1994
SNA 8	27	10	1/10/2005

1.2.2 Estimates of recreational harvest

There are two broad approaches to estimating recreational fisheries harvest: the use of onsite or access point methods where fishers are surveyed or counted at the point of fishing or access to their fishing activity; and, offsite methods where some form of post-event interview and/or diary are used to collect data from fishers.

The first estimates of recreational harvest were calculated using an onsite approach, a tag ratio method for SNA 1, in the mid-1980s (Table 6). A tonnes per tag ratio was obtained from commercial tag return data and this tonnage was multiplied by the number of tags returned by recreational fishers to estimate recreational harvest tonnages. The tag ratio method requires that all tagged fish caught by recreational fishers are recorded, or at least that the under-reporting rate of recreational fishers is the same as that of commercial fishers. This was assumed, although no data were available to test the assumption. If the recreational under-reporting rate was greater than that of the commercial fishers a negative bias would result. In SNA 8 there was evidence that many tags recovered by commercial fishing were reported as recreational catch during the 1991 tag recapture phase, which would give a positive bias to estimates.

The next method used to generate recreational harvest estimates was the offsite regional telephone and diary survey approach: MAF Fisheries South (1991–92), Central (1992–93), and North (1993–94) regions (Teirney et al 1997). Estimates for 1996 came from a national telephone and diary survey (Bradford 1998). Another national telephone and diary survey was carried out in 2000 (Boyd & Reilly 2002) and a rolling replacement of diarists in 2001 (Boyd et al 2004) allowed estimates for a further year (population scaling ratios and mean weights were not re-estimated in 2001). Other than for the 1991–92 MAF Fisheries South survey, the diary method used mean weights of snapper obtained from fish measured at boat ramps.

The harvest estimates provided by the telephone/diary surveys are no longer considered reliable for various reasons. With the early telephone/diary method, fishers were recruited to fill in diaries by way of a telephone survey that also estimates the proportion of the population that is eligible (likely to fish). A ‘soft refusal’ bias in the eligibility proportion arises if interviewees who do not wish to co-operate falsely state that they never fish. The proportion of eligible fishers in the population (and, hence, the harvest) is thereby under-estimated. Pilot studies for the 2000 telephone/diary survey suggested that this effect could occur when recreational fishing was established as the subject of the interview at the outset. Another equally serious cause of bias in telephone/diary surveys was that diarists who did not immediately record their day’s catch after a trip sometimes overstated their catch or the number of trips made. There is some indirect evidence that this may have occurred in all the telephone/diary surveys (Wright et al 2004).

The recreational harvest estimates provided by the 2000 and 2001 telephone/diary surveys are thought to be implausibly high for many species including snapper, which led to the development of an alternative maximum count aerial-access onsite method that provides a more direct means of estimating recreational harvests for suitable fisheries. The maximum count aerial-access approach combines data collected concurrently from two sources: a creel survey of recreational fishers returning to a subsample of ramps throughout the day; and an aerial survey count of vessels observed to be fishing at the approximate time of peak fishing effort on the same day. The ratio of the aerial count in a particular area to the number of interviewed parties who claimed to have fished in that area at the time of the overflight was used to scale up harvests observed at surveyed ramps, to estimate harvest taken by all fishers returning to all ramps. The methodology is further described by Hartill et al (2007).

This aerial-access method was first employed in the Hauraki Gulf in 2003–04 and was then extended to survey the wider SNA 1 fishery in 2004–05 and was used in 2011–12 and 2017–18 to corroborate concurrent national panel surveys. This approach has also been used to estimate recreational harvests from SNA 7 (2005–06 and 2015–16 fishing years) and SNA 8 (2006–07). The Marine Amateur Fisheries and Snapper Working Groups both concluded that this approach generally provided reliable estimates of recreational harvest for these fish stocks.

In response to the cost and scale challenges associated with onsite methods, in particular the difficulties in sampling other than trailer boat fisheries, offsite approaches to estimating recreational fisheries harvest have been revisited. This led to the implementation of a national panel survey during the 2011–12 fishing year (Wynne-Jones et al 2014). The panel survey used face-to-face interviews of a random sample of 30 390 New Zealand households to recruit a panel of fishers and non-fishers for a full year. The panel members were contacted regularly about their fishing activities and catch information was collected in computer-assisted standardised phone interviews. The national panel survey was repeated during the 2017–18 and 2022–23 fishing years using very similar methods to produce directly comparable results (Wynne-Jones et al 2019; Heinemann & Gray, in prep). Recreational catch estimates from the three national panel surveys are given in Table 6. Note that national panel survey estimates do not include recreational harvest taken on charter vessel trips or under s111 general approvals.

Monitoring harvest

In addition to estimating absolute harvests, a system to provide relative estimates of harvest over time for key fishstocks has been designed and implemented for some key recreational fisheries. The system uses web cameras to continuously monitor trends in trailer boat traffic at key boat ramps. This monitoring is complemented by creel surveys that provide estimates of the proportion of observed boats that were used for fishing, and of the average harvest of snapper and kahawai per boat trip. These data are combined to provide relative harvest estimates for SNA 1.

Trends inferred from this monitoring programme were initially very similar to that inferred from aerial-access harvest estimates in the Hauraki Gulf in 2004–05, 2006–07, and 2011–12, but the camera/creel snapper harvest estimate for the Hauraki Gulf in 2017–18 is substantially lower than concurrent aerial-access and national panel surveys estimates for the same year (Table 6a cf. Table 6). This difference appears to be due to a recent substantial increase in recreational fishing effort and catch around expanding mussel farms in the Firth of Thames, coinciding with a lesser increase in effort in the north-western Hauraki Gulf. Additional creel survey monitoring has been initiated to monitor changes in the recreational fishery in these areas, which had not been adequately monitored from boat ramps in the Auckland metropolitan area up until 2019–20. These estimates show that the recreational snapper harvest varies substantially more than would be expected if catches were related only to stock abundance; this suggests that changes in localised availability to recreational fishers can also have a marked effect on the recreational harvest. Web camera monitoring is continuing, and the coverage is being progressively extended to other FMAs.

1.2.2.1 SNA 1

Aerial-access surveys were conducted in FMA 1 in 2011–12 and 2017–18 (Hartill et al 2013, 2019) to independently provide harvest estimates for comparison with those generated from concurrent national panel surveys (excluding the Chatham Islands). Both surveys appear to have provided plausible results that corroborate each other and are therefore considered to be broadly reliable. Harvest estimates provided by these surveys are given in Table 6. Regional harvest estimates provided by the 2004–05 and 2011–12 aerial-access surveys were used to inform the 2013 stock assessment for SNA 1. Web camera/creel survey monitoring (see Table 6a) suggests that the recreational harvest of snapper in SNA 1 can vary greatly between years. The overall trend across all three regions of SNA 1 suggests a decline in the recreational harvest in the years following 2011–12, that was mostly driven by declining catch rates in the Hauraki Gulf. This was followed by a period of increasing recreational harvest in recent years, from 2015–16.

Table 6: Recreational catch estimates for snapper stocks. Totals for a stock are given in bold. The telephone/diary surveys ran from December to November but are denoted by the January calendar year. Mean fish weights were obtained from boat ramp surveys (for the telephone/diary and panel survey catch estimates). Numbers and mean weights are not calculated in the tag ratio method. Includes charter boat catch and panel survey estimates of s111 catches. [Continued on next page]

Stock	Year	Method	Number of fish (thousands)	Mean weight (g)	Total weight (t)	CV
SNA 1						
East Northland	1985	Tag ratio	–	–	370	–
Hauraki Gulf	1985	Tag ratio	–	–	830	–
Bay of Plenty	1984	Tag ratio	–	–	400	–
Total	1985[1]	Tag ratio	–	–	**1 600**	–
Total	1994	Telephone/diary	3 804	871	**2 857**	–
East Northland	1996	Telephone/diary	684	1 039	711	–
Hauraki Gulf/BoP	1996	Telephone/diary	1 852	870	1 611	–
Total	1996	Telephone/diary	2 540	915	**2 324**	–
East Northland	2000	Telephone/diary	1 457	1 154	1 681	–
Hauraki Gulf	2000	Telephone/diary	3 173	830	2 632	–
Bay of Plenty	2000	Telephone/diary	2 274	872	1 984	–
Total	2000	Telephone/diary	6 904	904	**6 242**	–
East Northland	2001	Telephone/diary	1 446	–[5]	1 669	–
Hauraki Gulf	2001	Telephone/diary	4 225	–[5]	3 507	–
Bay of Plenty	2001	Telephone/diary	1 791	–[5]	1 562	–
Total	2001	Telephone/diary	7 462	–[5]	**6 738**	–
Hauraki Gulf	2003–04	Aerial-access	–	–	1 334	0.09
East Northland	2004–05	Aerial-access	–	–	557	0.13
Hauraki Gulf	2004–05	Aerial-access	–	–	1 345	0.10
Bay of Plenty	2004–05	Aerial-access	–	–	516	0.10
Total	2004–05	Aerial-access	–	–	**2 419**	**0.06**
East Northland	2011–12	Aerial-access	–	–	718	0.14
Hauraki Gulf	2011–12	Aerial-access	–	–	2490	0.08
Bay of Plenty	2011–12	Aerial-access	–	–	546	0.12
Total	2011–12	Aerial-access	–	–	**3 754**	**0.06**
East Northland	2011–12	Panel survey	686	1 266	869	0.13
Hauraki Gulf	2011–12	Panel survey	2 216	1 022 / 987[6]	2 254	0.12
Bay of Plenty	2011–12	Panel survey	691	956 /1 003[6]	669	0.12
Total	2011–12	Panel survey	3 594	1 025	**3 792**	**0.08**
East Northland	2017–18	Aerial-access	–	–	720	0.10
Hauraki Gulf	2017–18	Aerial-access	–	–	2 068	0.07
Bay of Plenty	2017–18	Aerial-access	–	–	680	0.10
Total	2017–18	Aerial-access	–	–	**3 467**	**0.05**
East Northland	2017–18	Panel survey	563	1 351	761	0.12
Hauraki Gulf	2017–18	Panel survey	1 352	1 162/1 189	1 578	0.11
Bay of Plenty	2017–18	Panel survey	552	1 116/1 205	628	0.12
Total	2017–18	Panel survey	2 467	1 202	**2 967**	**0.07**
East Northland	2022–23	Panel survey	317	1 308	415	0.11
Hauraki Gulf	2022–23	Panel survey	608	1 044/997	629	0.09
Bay of Plenty	2022–23	Panel survey	378	1 243	470	0.13
Total	2022–23	Panel survey	130		**1 514**	**0.60**

1.2.2.2 SNA 2

National Panel Survey harvest estimates are available for SNA 2 from 2011–12 and 2017-18. Web camera/creel survey monitoring has been undertaken within SNA 2 since 2014–15 (monitoring at Napier and Gisborne). These data show a generally increasing trend in snapper harvest, but since the series only overlaps with one National Panel Survey (2017–18), scaled estimates of annual harvest (Table 6b) from the relative boat ramp harvest index should be considered preliminary (B. Hartill, pers. comm.).

Table 6 [Continued]: Recreational catch estimates for snapper stocks. Totals for a stock are given in bold. The telephone/diary surveys ran from December to November but are denoted by the January calendar year. Mean fish weights were obtained from boat ramp surveys (for the telephone/diary and panel survey catch estimates). Numbers and mean weights are not calculated in the tag ratio method. Includes charter boat catch and panel survey estimates of s111 catches.

Stock	Year	Method	Number of fish (thousands)	Mean weight (g)	Total weight (t)	CV
SNA 2						
Total	1993	Telephone/diary	28	1 282	**36**	–
Total	1996	Telephone/diary	31	1 282[2]	**40**	–
Total	2000	Telephone/diary	268	1 200[4]	**322**	–
Total	2001	Telephone/diary	144	–[5]	**173**	–
Total	2011–12	Panel survey	55	1 027	**57**	**0.25**
Total	2017–18	Panel survey	82	1 117	**91**	**0.24**
Total	2022–23	Panel survey	88	1 282/1 610	**116**	**0.25**
SNA 7						
Tasman Bay /Golden Bay	1987	Tag ratio	–	–	**15**	–
Total	1993	Telephone/diary	77	2 398[3]	**184**	–
Total	1996	Telephone/diary	74	2 398	**177**	–
Total	2000	Telephone/diary	63	2 148	**134**	–
Total	2001	Telephone/diary	58	–[5]	**125**	–
Total	2005–06	Aerial-access	–	–	**43**	**0.17**
Total	2011–12	Panel survey	110	799	**88**	**0.17**
Total	2015–16	Aerial-access	–	–	**83**	**0.18**
Total	2017–18	Panel survey	95	1 505	**144**	**0.16**
Total	2022–23	Panel survey	88	1 446/1 836	**130**	**0.14**
SNA 8						
Total	1991	Tag ratio	–	–	**250**	–
Total	1994	Telephone/diary	361	658	**238**	–
Total	1996	Telephone/diary	271	871	**236**	–
Total	2000	Telephone/diary	648	1 020	**661**	–
Total	2001	Telephone/diary	1 111	–	**1 133**	–
Total	2007	Aerial-access	–	–	**260**	**0.10**
Total	2011–12	Panel survey	557	770 /1 255 / 1 160[7]	**630**	**0.16**
Total	2017–18	Panel survey	654	–	**830**	**0.13**
Total	2022–23	Panel survey	355	1 500/1 359	**543**	**0.12**

[1] The Bay of Plenty programme was carried out in 1984 but is included in the 1985 total estimate.
[2] Mean weight obtained from 1992–93 boat ramp sampling.
[3] Mean weight obtained from 1995–96 boat ramp sampling.
[4] Mean weight obtained from 1999–2000 commercial landed catch sampling.
[5] The 2000 mean weights were used in the 2001 estimates.
[6] Separate mean weight estimates were used for summer (1 October 2011 to 30 April 2012) and for winter (1 May to 30 September 2012).
[7] Separate mean weight estimates were used for harbours (Kaipara and Manukau)/North coast (open coast fishery north of Tirua Point)/ South coast (open coast fishery south of Tirua Point).

Table 6a: Recreational catch estimates (t) for snapper in different parts of the SNA 1 stock area calculated from web camera and creel monitoring at key ramps combined with aerial-access estimates for each area in 2004–05 and 2006–07 (Hauraki Gulf only) and 2011–12 and 2018–19 (all areas within SNA 1).

Year	East Northland	CV	Hauraki Gulf	CV	Bay of Plenty	CV	Total SNA 1	CV
2004–05	730	0.14	1 216	0.13	605	0.15	2 551	0.08
2006–07	–	–	1 224	0.16	–	–	–	–
2011–12	689	0.13	2 772	0.09	596	0.18	4 057	0.07
2012–13	679	0.15	1 718	0.09	273	0.21	2 671	0.07
2013–14	540	0.12	876	0.13	216	0.19	1 632	0.08
2014–15	511	0.14	735	0.11	223	0.25	1 469	0.08
2015–16	647	0.13	657	0.15	171	0.19	1 475	0.09
2016–17	649	0.13	649	0.12	385	0.19	1 683	0.08
2017–18	751	0.13	1 037	0.11	623	0.16	2 410	0.08
2018–19	1 030	0.09	1 312	0.09	376	0.13	2 718	0.06

1.2.2.3 SNA 7

Plausible estimates for recreational catches from SNA 7 are available from the 1987 tagging programme, the aerial access surveys (in 2005–06 and 2015–16) and the national panel surveys (2011–12 and 2017–18). The estimates of recreational catch increased considerably from 2005–06 to 2017–18.

Table 6b: Preliminary recreational catch estimates for SNA 2, split by SNA 2N and SNA 2S, on basis of National Panel Survey and web camera/creel survey monitoring.

Year	SNA 2N	SNA 2S	SNA 2	source
2011–12	29.5	26.3	55.8	NPS
2012–13				
2013–14				
2014–15	10.9	25.8	36.7	Scaled creel survey
2015–16	18.4	33.6	52.0	Scaled creel survey
2016–17	13.9	36.5	50.4	Scaled creel survey
2017–18	35.2	57.9	93.1	NPS
2018–19	41.8	87.8	129.7	Scaled creel survey
2019–20	34.6	43.8	78.4	Scaled creel survey
2020–21	53.1	60.5	113.6	Scaled creel survey

Most of the recreational catch has been recorded from Tasman Bay and Golden Bay. The catch is predominantly taken by rod-and-line, although a significant proportion of the catch was taken by longline during the mid 2010s. A small proportion of the total SNA 7 recreational catch was recorded from the Marlborough Sounds.

1.2.2.4 SNA 8

In 2005, the Snapper Working Group and Plenary considered recreational catches from SNA 8. Two alternative levels were assumed for the recreational catch from 1990 to 2004, either 300 t or 600 t. The Plenary considered these values were likely to bracket the true average level of catch in this period. The estimate from the 2006–07 aerial overflight survey of the SNA 8 fishery (260 t) suggests that the assumed value of 300 t may have been the more plausible. There are potential sources of bias associated with the aerial-access estimate, both negative (a potential underestimation of the shore-based harvest, especially to the south) and positive (over-reporting of harvests by charter boat operators in a log book survey which are included in the estimate). The 2011–12 and 2017–18 national panel surveys provided plausible results and are considered to be broadly reliable and suggest that catch is increasing. Web camera/ creel survey monitoring in SNA 8 started in late 2011 and has found no general trend in fishing effort, but a gradual fluctuating increase in catch rates and hence harvest, since that time. No estimates of absolute catch have yet been developed from these data.

1.3 Customary non-commercial fisheries

Snapper form important fisheries for customary non-commercial, but the annual catch is not known. The information on Māori customary harvest under the provisions made for customary fishing is limited (Table 6c). It is likely that Māori customary fishers utilise the provisions under recreational fishing regulations. Customary reporting varies within SNA 8. Large areas of SNA 8 are gazetted under the

Fisheries (Kaimoana Customary Fishing) Regulations 1998 which require reporting on authorisations. In the areas not gazetted, customary fishing authorisations issued would be under the Fisheries (Amateur Fishing) Regulations 2013, where there is no requirement to report. The numbers reported in Table 6b may be underestimated.

Table 6c: Customary approvals and reported harvest in SNA 8 from 2005–06 to present.

Year	Quantity approved (kg)	Reported actual quantity harvested (kg)	Number of authorisations issued
2005–06	250		4
2006–07	120	40	2
2007–08	130	30	2
2008–09	330	151	5
2009–10	4 747	3 046	14
2010–11	5 130	3 089	14
2011–12	3 800	2 633	16
2012–13	4 367	2 439	17
2013–14	12 825	4 514	30
2014–15	17 730	5 887	20
2015–16	14 388	6 553	31
2016–17	3 693	1 669	17
2017–18	770	534	11
2018–19	7 090	1 344	32
2019–20	15 500	2 422	34
2020–21	9 770	270	24
2021–22	2 460		7
2022–23	29 225		74

There are no estimates of customary catch available for SNA 7. Current levels of customary catch in SNA 7 are considered to be small and are assumed to be included into recreational catch estimates.

1.4 Illegal catch

No new analyses are available that provide estimates of illegal catch. For modelling SNA 1, SNA 7, and SNA 8, an assumption was made that non-reporting of catch was 20% of reported domestic commercial catch prior to 1986 and 10% of reported domestic commercial catch since the QMS was introduced. This was to account for all forms of under-reporting. These proportions were estimated in 1996, taking account of information on the black-market trade in snapper and higher levels of under-reporting (to avoid tax) that existed prior to the introduction of the QMS. The 10% under-reporting post-QMS accounts for the practice of under-recording of landed weights and the discarding of legal-size snapper. From 2016–2018 all snapper 1 trawl vessels participated in a video observation programme (Middleton & Guard 2021); the focus of that project was verification of the quantity of undersized fish returned to the sea, but significant discarding of legal-sized snapper by these vessels was unlikely during this period.

1.5 Other sources of mortality

No estimates are available regarding the amount of other sources of mortality on snapper stocks; although high-grading of longline fish and discarding of under-sized fish by all methods occurs. An at-sea study of SNA 1 commercial longline fisheries in 1997 (McKenzie 2000) found that 6–10% of snapper caught by number were under 25 cm (MLS). Results from a holding net study indicate that mortality levels amongst lip-hooked snapper caught shallower than 35 m were low.

Estimates for incidental mortality were based on other catch-at-sea data using an age-length structure model for longline, trawl, seine, and recreational fisheries. In SNA 1, estimates of incidental mortality for the year 2000 from longlines were less than 3% and for trawl, seine, and recreational fisheries between 7% and 11% (Millar et al 2001). In SNA 8, estimates of trawl and recreational incidental mortality were lower, mainly because of low numbers of 2- and 3-year old fish estimated in 2000.

With the introduction of Electronic Reporting in 2019, commercial fishers must provide comprehensive reporting of all discards and returns. All fish under the minimum legal size ("sub-MLS fish”) must be returned to the sea.

In SNA 1, recreational fishers release a high proportion of their snapper catch, most of which was less than 30 cm (recreational MLS). An at-sea study in 2006–07 recorded snapper release rates of 54.2% of the catch by trailer boat fishers and 60.1% of the catch on charter boats (Holdsworth & Boyd 2008). Incidental mortality estimated from condition at release was 2.7% to 8.2% of total catch by weight depending on assumptions used.

2. BIOLOGY

Snapper are demersal fish found down to depths of about 200 m, but are most abundant in 15–60 m. They are the dominant fish in northern inshore communities and occupy a wide range of habitats, including rocky reefs and areas of sand and mud bottom. They are widely distributed in the warmer waters of New Zealand, being most abundant in the Hauraki Gulf.

Although all snapper undergo a female phase as juveniles, after maturity each individual functions as one sex (either male or female) during the rest of its life. Sexual maturity occurs at an age of 3–4 years and a length of 20–28 cm; and the sex ratio of the adult population is approximately 50:50. Snapper are serial spawners, releasing many batches of eggs over an extended season during spring and summer. The larvae have a relatively short planktonic phase which results in the spawning grounds corresponding fairly closely with the nursery grounds of young snapper. Juvenile snapper (0+) are known to reach high abundances in shallow west and east coast harbours and estuaries around the northern half of the North Island and have also been observed in catches from trawl surveys conducted in shallow coastal waters around northern New Zealand, East Cape, Hawke Bay and Tasman Bay and Golden Bay. Despite observations of spawning condition adults along the Wairarapa and Kapiti coasts, 0+ snapper have yet to be found in these areas. Young snapper disperse more widely into less sheltered coastal areas as they grow older. Large schools of snapper congregate before spawning and move on to the spawning grounds, usually in November–December. The spawning season may extend to January–March in some areas and years before the fish disperse, often inshore to feeding grounds. The winter grounds are thought to be in deeper waters where the fish are more widespread.

Water temperature appears to play an important part in the success of recruitment. Generally strong year classes in the population correspond to warm years, weak year classes correspond to cold years (Francis 1993).

Growth rate varies geographically and from year to year. Snapper from SNA 2, Tasman Bay/Golden Bay and off the west coast of the North Island grow faster and reach a larger average size than elsewhere. Snapper have a strong seasonal growth pattern, with rapid growth from November to May, and then a slowing down or cessation of growth from June to September. They may live up to 60 years or more and have very low rates of natural mortality. An estimate of $M = 0.06\ yr^{-1}$ was made from catch curves of commercial catches from the west coast North Island pair trawl fishery in the mid-1970s. These data were re-analysed in 1997 and the resulting estimate of $0.075\ yr^{-1}$ has been used in the base case assessments for SNA 1, 2, 7, and 8.

Regular sampling has provided evidence that growth rates of snapper in SNA 1, SNA 7 and SNA 8 have also varied over time. For SNA 8, growth rates were considerably higher during the 1980s and 1990s compared with the 1970s and more recent period (from mid-2000s). The SNA 7 and SNA 8 growth parameters in Table 7 were derived from age-length observations from the early 1990s and, hence, represent the period of higher growth rates. The temporal variation in growth may indicate density-dependence in the growth rates of snapper, at least in SNA 1, SNA 7 and SNA 8, given the historical exploitation patterns of those stocks. Estimates of biological parameters relevant to stock assessment are shown in Table 7.

Table 7: Estimates of biological parameters.

Fishstock	Estimate			Source
1. Instantaneous rate of natural mortality (*M*)				
SNA 1, 2, 7, & 8	0.075			Hilborn & Starr (unpub. analysis)
2. Weight = *a*(length)^b (Weight in g, length in cm fork length)				
All	*a* = 0.04467	*b* = 2.793		Paul (1976)
3. von Bertalanffy growth parameters				
	Both sexes combined			
	K	t_0	L_∞	
SNA 1	0.102	-1.11	58.8	Gilbert & Sullivan (1994)
SNA 2	0.061	-5.42	68.9	NIWA (unpub. analysis)
SNA 7 (1990s)	0.122	-0.71	69.6	MPI (unpub. data)
SNA 8 (1990s)	0.16	-0.11	66.7	Gilbert & Sullivan (1994)
4. Age at recruitment (years)				
SNA 1*	4 (39%) 5 (100%)			Gilbert et al (2000)
SNA 7	3			MPI (unpub. data)
SNA 8	3			Gilbert & Sullivan (1994)

* For years when not estimated.

3. STOCKS AND AREAS

New Zealand snapper are thought to comprise either seven or eight biological stocks based on: the location of spawning and nursery grounds; differences in growth rates, age structure, and recruitment strength; and the results of tagging studies. These stocks are assumed to comprise three in SNA 1 (East Northland, Hauraki Gulf, and Bay of Plenty (BoP)), two in SNA 2 (one of which may be associated with the BoP stock), two in SNA 7 (Marlborough Sounds and Tasman Bay/Golden Bay) and one in SNA 8. Tagging studies reveal that limited mixing occurs between the three SNA 1 biological stocks, with greatest exchange between BoP and Hauraki Gulf.

Tagging studies in SNA 8 have shown considerable movements of fish between South Taranaki Bight and the area north of Cape Egmont. However, recent *Kaharoa* WCNI trawl surveys indicate some differences in the age structure of snapper between the two areas which may suggest a degree of spatial stratification of the SNA 8 stock.

Tagging studies in SNA 7 (1986/87) and SNA 8 (1990) revealed reciprocal movements of snapper between Tasman Bay/Golden Bay and South Taranaki Bight, although the scale of the movement was relatively low during that period.

Location-based snapper catch data from the trawl fisheries in SNA 7 and southern SNA8 has revealed an overlap of the distribution of snapper catches in western approaches to Cook Strait between Durville Island and Kapiti Island, particularly since 2014/15. Snapper age compositions are available from recent (2018-2020) *Kaharoa* trawl surveys of the South Taranaki Bight and the Tasman Bay/Golden Bay area of the WCSI trawl survey. There are strong differences in the relative strength of individual year classes from the 2019 South Taranaki Bight age composition compared to the 2018 and 2020 surveys, while the 2019 STB age composition was very similar to the age structures from the 2019 Tasman Bay/Golden Bay trawl survey and the commercial fishery in the TBGB area. These observations indicate a degree of mixing of the snapper populations between SNA 7 and the STB area (SNA8), although the extent of mixing may vary between years, potentially related to variation in the timing of the main spawning period in each area.

4. ENVIRONMENTAL AND ECOSYSTEM CONSIDERATIONS

This section was last updated from the 2022 Fisheries Assessment Plenary. An issue-by-issue analysis is available in the Aquatic Environment and Biodiversity Annual Review 2021 (Fisheries New Zealand 2021), online at https://www.mpi.govt.nz/dmsdocument/51472-Aquatic-Environment-and-Biodiversity-Annual-Review-AEBAR-2021-A-summary-of-environmental-interactions-between-the-seafood-sector-and-the-aquatic-environment.

4.1 Role in the ecosystem

Snapper are one of the most abundant demersal generalist predators found in the inshore waters of northern New Zealand (Morrison & Stevenson 2001, Kendrick & Francis 2002), and as such are likely to be an important part of the coastal marine ecosystem (Salomon et al 2008). Localised depletion of snapper probably occurs within the key parts of the fisheries (Parsons et al 2009), and this has unknown consequences for ecosystem functioning in those areas.

4.1.1 Trophic interactions

Snapper are generalists, occupying nearly every coastal marine habitat less than 200 m deep. Because of this generalist nature there is a large potential for a variety of trophic interactions to involve snapper. The diet of snapper is diverse and opportunistic and largely includes crustaceans, polychaetes, echinoderms, molluscs, and other fish (Godfriaux 1969, Godfriaux 1974). As snapper increase in size, harder bodied and larger diet items increase in importance (e.g., fish, echinoids, hermit crabs, molluscs, and brachyuran crabs) (Godfriaux 1969, Usmar 2012). There is some evidence to suggest a seasonal component to snapper diet, with high proportions of pelagic items (e.g., salps and pelagic fish such as pilchards) observed during spring in one study (Powell 1937).

There is some evidence to suggest that snapper can influence the environment that they occupy in some situations. On some rocky reefs, recovery of predators inside marine reserves (including snapper and rock lobster, *Jasus edwardsii*) has led to the recovery of algal beds through predation exerted on herbivorous urchins (Babcock et al 1999, Shears & Babcock 2002). Snapper competes with other species; overlap in diet is likely with a number of other demersal predators (e.g., tarakihi, red gurnard, trevally, rig, and eagle ray). The wide range of prey consumed by these species and differences in diet preference and habitat occupied, however, is likely to reduce the amount of competition overall (Godfriaux 1970, 1974). The importance of snapper as a food source for other predators is poorly understood.

4.1.2 Ecosystem Indicators

Tuck et al (2009) used data from the Hauraki Gulf trawl survey series (up to 2000) to derive fish-based ecosystem indicators using diversity, fish size, and trophic level. This trawl survey series covers a key component of the distribution of snapper. Tuck et al (2009) showed decreasing trends in the proportion of species with low resilience (from FishBase, Froese & Pauly 2000) and the proportion of demersal fish species in waters shallower than 50 m in the Hauraki Gulf. Several indices of fish diversity showed significant declines in muddy waters shallower than 50 m, especially in the Firth of Thames. Tuck et al (2009) did not find size-based indicators as useful as they have been overseas, but there was some indication that the maximum size of fish has decreased in the Hauraki Gulf survey area, especially over sandy bottoms. Since 2008, routine measurement of all fish species in New Zealand trawl surveys has been undertaken and this may increase the utility of size-based indicators in the future.

4.2 Bycatch (fish and invertebrates)

Snapper in SNA 1 is the declared target species, but tends to be more of a bycatch species in SNA 2, SNA 7 and SNA 8, particularly in inshore trawl fisheries. No summaries of observed fish and invertebrate bycatch in snapper target fisheries are currently available, although there is extensive information on commercial bycatch, which is documented in stock characterisations routinely undertaken.

4.3 Incidental capture of protected species (mammals, seabirds, turtles, and protected fish)

For protected species, capture estimates presented here include all animals recovered to the deck (alive, injured, or dead) of fishing vessels but do not include any cryptic mortality (e.g., seabirds struck by a warp or caught on a hook but not brought onboard the vessel, Middleton & Abraham 2007, Brothers et al 2010).

4.3.1 Marine mammal captures

There were two observed captures of New Zealand fur seals in trawls targeting snapper between 2002–03 and 2019–20, but historically low observer coverage of inshore trawlers (average 6.98% in FMAs 1 and 9 between 2002–03 and 2017–18, but averaging 20.51% between 2013–14 and 2017–18) (https://psc.dragonfly.co.nz/2019v1/released/new-zealand-fur-seal/inshore-trawl/all-vessels/eez/2002-03-2017-18/) means that the frequency of captures is highly uncertain. In the same time period, there were no observed marine mammal captures in snapper longline fisheries, when coverage has averaged 2.18% of hooks set (2.5 and 7.3% in the two most recent years) (Protected species bycatch (protectedspeciescaptures.nz)).

Observers recorded two dolphin deaths during snapper trawling in 2016–17: one common dolphin from off the North Island east coast and one bottlenose dolphin from the Northland-Hauraki Gulf area (Abraham et al 2021).

4.3.2 Seabird interactions and captures

There have been thirteen observed captures of seabirds (3 flesh-footed shearwater, 3 black petrel, 2 shearwaters that were not identified further, and 2 common diving petrel, 2 New Zealand white-faced storm petrel and an unidentified small seabird) and 26 observed deck strikes (10 common diving petrels, 10 grey-faced petrel, 2 Buller's shearwater, 1 flesh-footed shearwater, 1 cape petrel, 1 black petrel, and 1 Cook's petrel) in trawls targeting snapper between 2002–03 and 2019–20, but historically low observer coverage of inshore trawlers (average 6.98% in FMAs 1 and 9 between 2002–03 and 2017–18, but averaging 20.51% between 2013–14 and 2017–18) means that the frequency of interactions is highly uncertain. (Protected species bycatch (protectedspeciescaptures.nz))

The estimated number of total incidental captures of all seabirds in the snapper bottom longline fishery declined from 3436 in 2000–01 to 247–644 in 2003–04 (depending on the model used, Table 8, estimates from MacKenzie & Fletcher 2006, Baird & Smith 2007, 2008, Abraham & Thompson 2011a). The estimated number of captures between 2003–04 and 2006–07 appears to have been relatively stable at about 400–600 birds each year.

Table 8: Model based estimates of seabird captures in the SNA 1 bottom longline fishery from 1998–99 to 2006–07 (from MacKenzie & Fletcher 2006 (for vessels under 28 m), Baird & Smith 2007, 2008, Abraham & Thompson 2011a). Numbers in parentheses are 95% confidence limits or estimated CVs.

Fishing year	MacKenzie & Fletcher		Baird & Smith		Abraham & Thompson	
1998–99	1 464	(271–9 392)	–	–	–	–
1999–00	2 578	(513–13 549)	–	–	–	–
2000–01	3 436	(697–17 907)	–	–	–	–
2001–02	1 856	(353–11 260)	–	–	–	–
2002–03	1 583	(299–9 980)	–	–	739	(332–1 997)
2003–04	247	(51–1 685)	546	(CV = 34%)	644	(301–1 585)
2004–05	–	–	587	(CV = 42%)	501	(245–1 233)
2005–06	–	–	–	–	469	(222–1 234)
2006–07	–	–	–	–	457	(195–1 257)

Between 2002–03 and 2017–18, there were 156 observed captures of birds in snapper bottom longline fisheries (Table 9). Estimates of the mean total seabird captures from 2002–03 to 2017–18 vary from 713 to 325 based on a consistent capture rate. The rate of capture varied between 0.0 and 0.1 birds per 1000 hooks observed, fluctuating without obvious trend. Seabirds observed captured in snapper longline fisheries were mostly flesh-footed shearwater (53%) and black (Parkinson's) petrel (24%), and the majority were taken in the Northland-Hauraki area (88%) (Table 10). These numbers should be regarded as only a general guide on the composition of captures because the observer coverage is low, is not uniform across the area, and may not be representative.

Table 9: Number of tows by fishing year, observed, and estimated seabird captures in the snapper bottom longline fishery, 2002–03 to 2019–20. No. obs, number of observed hooks; % obs, percentage of hooks observed; Rate, number of captures per 1000 observed hooks. Estimates are based on methods described by Abraham et al (2016) and Abraham & Richard (2017, 2018) and are available via Protected species bycatch (protectedspeciescaptures.nz). Observed and estimated protected species captures in this table derive from the PSC database version PSCV6.

		Fishing effort		Observed captures		Estimated captures		
	All hooks	No. obs	% obs	Number	Rate	Mean	95% c.i.	% included
2002–03	13 728 672	0	0.0	0	–	713	522-942	93.2
2003–04	12 266 197	187 282	1.5	10	0.05	636	471-850	100.0
2004–05	11 542 491	244 692	2.1	13	0.05	573	421-766	100.0
2005–06	11 695 613	116 288	1.0	12	0.10	454	324-622	93.1
2006–07	10 348 741	62 360	0.6	0	0.00	438	319-599	93.4
2007–08	9 047 522	0	0.0	0	–	426	302-583	100.0
2008–09	8 981 466	318 274	3.5	27	0.08	441	322-594	100.0
2009–10	11 041 405	634 145	5.7	32	0.05	471	343-633	100.0
2010–11	11 343 582	0	0.0	0	–	497	356-676	100.0
2011–12	11 037 136	0	0.0	0	–	446	318-613	100.0
2012–13	10 501 460	366 120	3.5	2	0.01	418	301-567	100.0
2013–14	11 122 634	747 597	6.7	47	0.06	426	315-573	100.0
2014–15	10 845 182	0	0.0	0	–	356	250-492	100.0
2015–16	10 611 551	337 125	3.2	7	0.02	336	238-463	100.0
2016–17	10 757 586	486 700	4.5	5	0.01	338	235-469	100.0
2017–18	10 427 687	327 091	3.1	14	0.04	325	228-447	100.0
2018–19	10 811 176	269 659	2.5	3	0.01	354	245-485	100.0
2019–20	11 067 703	806 795	7.3	14	0.02	363	260-495	100.0

The snapper target bottom longline fishery contributes to the total risk posed by New Zealand commercial fishing to seabirds (Table 11). The two species to which the fishery poses the most risk are black petrel and flesh-footed shearwater, with this target fishery posing 0.4421 and 0.2166 of PST, respectively (Table 11). The black petrel is assessed at very high risk from commercial fishing in New Zealand waters, and the flesh-footed shearwater is assessed at high risk from commercial fishing in New Zealand waters (Richard et al 2020).

Table 10: Number of observed seabird captures in the snapper longline fishery, 2002–03 to 2018–19, by species or species group. The risk category is an estimate of aggregate potential fatalities across trawl and longline fisheries relative to the Population Sustainability Threshold, PST (from Richard et al 2017, where full details of the risk assessment approach can be found). Observed and estimated protected species captures in this table derive from the PSC database version PSCV4, www.data.dragonfly.co.nz/psc.

Taxa	Risk category	Northland and Hauraki	Bay of Plenty	West Coast North Island	Taranaki
Black petrel	Very high	40	0	0	0
Flesh-footed shearwater	High	76	11	0	7
Northern giant petrel	Medium	1	0	0	0
Pied shag	Negligible	2	0	0	0
Fluttering shearwater	Negligible	6	0	0	0
Sooty shearwater	Negligible	2	0	0	0
Australasian gannet	Negligible	2	0	0	0
Buller's shearwater	Negligible	13	0	1	0
Southern black-backed gull	Negligible	5	0	0	0
Petrels	–	3	1	0	1
Total birds	–	163	14	1	8

Table 11: Risk ratio of seabirds predicted by the risk assessment for the snapper target bottom longline fishery and all fisheries included in the risk assessment, 2006–07 to 2016–17, showing seabird species with a risk ratio of Very High or High; estimates at a fishery-specific level were not available for other species. The risk ratio is an estimate of aggregate potential fatalities across trawl and longline fisheries relative to the Population Sustainability Threshold, PST (from Richard et al 2017, where full details of the risk assessment approach can be found). The DOC threat classifications are given by (Robertson et al 2017 at http://www.doc.govt.nz/documents/science-and-technical/nztcs19entire.pdf).

		Risk ratio			
Species name	PST (mean)	SNA target bottom longline	Total	Risk category	DOC Threat Classification
Black petrel	447	0.4421	1.23	Very high	Threatened: Nationally Vulnerable
Flesh-footed shearwater	1 450	0.2166	0.49	High	Threatened: Nationally Vulnerable

4.3.3 Sea turtle captures

Between 2002–03 and 2019–20 there was one observed capture of a green turtle in the snapper bottom longline fishery occurring in the Northland and Hauraki fishing area. Observer records documented the green turtle as captured and released alive (Fisheries New Zealand unpublished data). In the same period, there were no captures of turtles in the snapper trawl fishery.

4.3.4 Protected fish captures

White pointer sharks (*Carcharodon carcharias*, also known as great white shark) were protected in New Zealand waters in 2007 under the Wildlife Act 1953, but they are incidentally caught in commercial and recreational fisheries (Francis & Lyon 2012). Fishers have reported catching a total of 24 white pointer shark individuals in snapper trawls since 2009, 4 of which were dead upon capture, 5 were released alive but injured, and the remainder were released alive. Little is known about the survival of released individuals, but it is assumed to be low.

4.4 Benthic interactions

The spatial extent of seabed contact by trawl fishing gear in New Zealand's EEZ and Territorial Sea has been estimated and mapped for all trawl fisheries combined (Baird & Mules 2021). This most recent analysis provides an assessment of the inshore trawl footprint was for the period 2007–08 to 2020-21 (MacGibbon & Mules 2023).

A total of almost 49 700 bottom contacting tows have targeted snapper between 2007–08 and 2020–21. Annual numbers fluctuated around 4000 tows per year up to 2012–13 but have declined to around 2400 since 2015–16 (MacGibbon & Mules 2023). The total aggregate area fished between 2007–08 and 2020-21 was 55 629 km^2. This has mostly (67%) been within SNA 1, where annual aggregate area fished declined from around 3000 km^2 (2007–08 to 2012–13) to 2100 km^2 (2016–17), before increasing to around 3000 km^2 (2017–18 and 2020–21). Annual area fished within SNA 2 and SNA 7 has fluctuated around 350 km^2; whereas in SNA 8, the annual area fished declined from 1300 km^2 in 2007–08 to 480 km^2 by 2010–11 and has fluctuated around this level since this time (MacGibbon & Mules 2023).

A proportion of the commercial catch of snapper is taken using bottom trawls in Benthic Optimised Marine Environment Classification (BOMEC, Leathwick et al 2012) classes A, C (northern shelf), and H (shelf break and upper-slope) (Baird & Wood 2012), and at least 90% of trawls occur shallower than 100 m depth (Baird et al 2011, tabulating data from TCEPR forms). Trawling for snapper, like trawling for other demersal species, is likely to have effects on benthic community structure and function (e.g., Thrush et al 1998, Rice 2006) and there may be consequences for benthic productivity (e.g., Jennings et al 2001, Hermsen et al 2003, Hiddink et al 2006, Reiss et al 2009). These consequences are not considered in detail here but are discussed in the Aquatic Environment and Biodiversity Annual Review 2021 (Fisheries New Zealand 2021).

4.5 Other considerations

4.5.1 Spawning disruption

Fishing within aggregations of spawning fish may have the potential to disrupt spawning behaviour and, for some fishing methods or species, may lead to reduced spawning success. No research has been conducted on disruption of snapper spawning, but aggregations of spawning snapper often receive high commercial and recreational fishing effort (Fisheries New Zealand unpublished data). Areas likely to be important for snapper spawning include the Hauraki Gulf (Cradock Channel, Coromandel Harbour to the Firth of Thames, and between the Noises, Tiritiri Matangi, and Kawau Islands (Zeldis & Francis 1998)), Rangaunu and Doubtless Bay, the Bay of Islands, eastern Bay of Plenty, and the coastal areas adjacent to the harbour mouths on the west coast such as Manukau Harbour and Kaipara Harbour (Hurst et al 2000).

4.5.2 Genetic effects
Fishing, environmental changes, including those caused by climate change or pollution, could alter the genetic composition or diversity of a species. Bernal-Ramírez et al (2003) estimated genetic diversity and confidence limits for snapper in Tasman Bay and the Hauraki Gulf. They showed a significant decline of both mean heterozygosity and mean number of alleles in Tasman Bay, but only random fluctuations in the Hauraki Gulf. In Tasman Bay, there was a decrease in genetic diversity at six of seven loci examined, compared with only one in the Hauraki Gulf. Bernal-Ramírez et al (2003) associated this decline with overfishing of the SNA 7 stock and estimated the effective population size in Tasman Bay declined to a low level between 1950 and 1998.

4.5.3 Habitat of particular significance to fisheries management
Habitat of particular significance for fisheries management (HPSFM) does not have a policy definition (Ministry for Primary Industries 2013). For juvenile snapper, it is likely that certain habitats, or locations, are critical to successful recruitment of snapper. Post settlement juvenile snapper (10–70 mm fork length) associate strongly with three-dimensional structured habitats in estuaries, harbours, and sheltered coastal areas (such as beds of seagrass and horse mussels, Thrush et al 2002, Morrison et al 2009, 2014a, b). The reason for this association is currently unclear, but the provision of food and shelter are likely explanations. Some potential nursery habitats appear to contribute disproportionately to their area. For example, the Kaipara Harbour in northern New Zealand contributed to more than 75% of the recruits to the SNA 8 fishery in 2003 (Morrison, NIWA, unpublished data, Morrison et al 2009) and a similar situation exists for snapper from Port Phillip Bay in Australia (Hamer et al 2011). These habitats are subject to land-based stressors (Morrison et al 2009, Lowe et al 2015) that may affect the survival of juvenile snapper and hence recruitment to the SNA 8 fishery. It should, however, be noted that recruitment over the last decade has been exceptionally good, suggesting that environmental factors affecting egg and larval survival in the ocean have had greater influence on the number of fertilised eggs surviving to adulthood.

5. RECRUITMENT, ENVIRONMENTAL VARIABILITY, AND CLIMATE CHANGE

This section was last updated in May 2021.

Recruitment dynamics are challenging to assess or predict because of the many underlying drivers that vary over time and space. Stock size, demographic and trait composition, condition and distribution of spawning fish, and the spatio-temporal dynamics of trophic and environmental interactions all influence recruitment processes. Annual variations in snapper recruitment have considerable impact on this fishery and improved understanding of the influence of environmental variables on recruitment patterns would be very useful for the future projection of stock size under different climate change scenarios and different environmental conditions.

New Zealand waters are becoming warmer and more acidic due to the emission of anthropogenic carbon dioxide (Law et al 2018a, 2018b). Recruitment success of New Zealand snapper has been highly correlated with warmer conditions (Francis 1993, Harley & Gilbert 2000, Zeldis et al 2005, Dunn et al 2009, Langley 2015, Garg 2020). Snapper recruitment fluctuations may significantly influence biomass where: 1) a series of weak or strong year classes occur in adjacent years, 2) a population is heavily fished and thus more easily dominated by younger year classes, or 3) a population is near the geographic limit of its range and is dominated by a few year classes due to irregular recruitment; each of which has occurred in at least one snapper stock in New Zealand (Francis 1993).

Recruitment in SNA 7 and SNA 8 has been above average in recent years (Langley 2020a, 2020b). Some spatial differences in year class strength (YCS) patterns are evident across different stocks, but appear to be reasonably well correlated, which may be a result of each stock showing similar responses to broad climatic phenomena, such as the Southern Oscillation Index (SOI) (Francis & Mackenzie 2015). Stock assessments have estimated high levels of recruitment in SNA 7 and SNA 8 between 2006 and 2019 (Langley 2015, 2020a, 2020b), which may possibly be linked to increasing water temperatures. It should nevertheless be noted that the relationship between recruitment and water temperature is unlikely to be linear, with growth and recruitment decreasing after reaching an optimum thermal maxima for Australian snapper populations (Fowler & Jennings 2003, Murphy 2013). It is unclear what the thermal maxima will be for snapper in New Zealand.

In SNA 7, recruitment has been shown to be positively correlated with air temperature (Harley & Gilbert 2000). Strong year classes have also been linked to positive SOI conditions, whereas weak year classes have been linked to negative SOI conditions (Langley 2015). More recently, Garg (2020) examined environment-recruitment relationships for SNA 1 (1970–2007) and SNA 7 (1982–2012) using generalised linear models based on annual recruitment estimates from stock assessment models that incorporated age data from otolith samples. The most variation in YCS was explained by the mean autumn (April–June) SST in SNA 1 and by mean annual SOI in SNA 7, and the Interdecadal Pacific Oscillation accounted for the second greatest amount of variation in both SNA 1 and SNA 7. These findings were consistent with Francis (1993), who concluded that water temperature appears to play an important part in the success of recruitment, with strong year classes in the population generally corresponding to warm years, and weak year classes to cold years. As well as finding a positive correlation between YCS and SST, Dunn et al (2009) also found a positive correlation between YCS and SOI for SNA 1.

A recent study found that fishing and environmental factors initially promote individual fish growth of snapper, but regional-scale wind and temperature may also increase the sensitivity of stocks to environmental change (Morrongiello et al 2021).

Temperature-recruitment relationships are typically non-linear, and studies on snapper in South Australia have shown a reduction in recruitment after temperatures rose above 25 °C (Fowler & Jennings 2003). In Western Australia, snapper growth is greatest at mid latitudes with more moderate temperatures, and lowest at the northern limit of the geographical range for snapper, where temperatures are at their highest (Wakefield et al 2017). In South Australia, biochronology work has found an optimal temperature maximum of 18–20 °C for growth in snapper, and temperatures greater than this result in slower growth rates (Martino et al 2019), which was also in support of optimum growth conditions for juvenile snapper ascertained from aquaculture experimental studies (Fielder et al 2005). The Hauraki Gulf is currently experiencing temperatures near 20 °C, but the optimal temperature range for snapper stocks in New Zealand is unknown (Parsons et al 2020). Recent Hauraki and Bay of Plenty trawl surveys which monitored snapper recruitment and compared it to SST show that the estimated year class strength of 1+ and 2+ snapper in the Hauraki Gulf 2019 survey was well above the long-term average, whereas in the Bay of Plenty, YCSs were well above average (1+) and about average (2+) (see Parsons & Bian in prep).

Several causal mechanisms may result in the increased production of prey and a faster larval growth rate of snapper (Murphy 2013). Zeldis et al (2005) found that wind-driven upwelling caused increased flux of shelf water into the Hauraki Gulf, resulting in greater primary productivity, prey abundance, and higher larval snapper survival.

Ocean acidification (OA) has been shown to have a variable influence on snapper larvae. Although higher temperature and carbon dioxide levels may positively impact growth and survival of snapper larvae, this effect may be countered by the negative effects of elevated carbon dioxide on metabolic rates and swimming performance (McMahon et al 2020a, 2020b). Modelling the overall effect from both OA and warming on snapper populations estimated a 29% reduction to a 44% increase in fishery yield and therefore remains highly uncertain (Parsons et al 2020).

Cummings et al (2021) assessed the vulnerability of New Zealand's snapper fishery to projected environmental change as 'moderate' and outlined the following potential outcomes of increased sea temperatures: 1) southward range expansion, 2) change in distribution of predators, competitors, parasites, and disease, and 3) toxicity and decreased dissolved oxygen due to harmful algal blooms. In recent years, snapper populations appear to have been increasing, in some areas substantially, suggesting that environmental conditions are currently favourable for snapper recruitment and survival.

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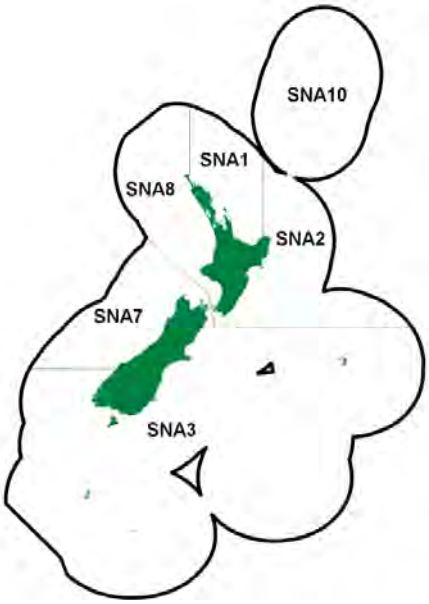
SNAPPER (SNA 7)

(*Chrysophrys auratus*)
Tamure, Kouarea



1. FISHERIES SUMMARY

1.1 Commercial fisheries

Table 1 and Table 2 provide a summary by fishing year of the reported commercial catches, TACCs, and TACs for SNA 7. Landings and TACC are plotted in Figure 1.

Table 1: Reported landings (t) of snapper from SNA 7 from 1931 to 1990.

Year	SNA 7	Year	SNA 7
1931–32	69	1961	583
1932–33	36	1962	582
1933–34	65	1963	569
1934–35	7	1964	574
1935–36	10	1965	780
1936–37	194	1966	1 356
1937–38	188	1967	1 613
1938–39	149	1968	1 037
1939–40	158	1969	549
1940–41	174	1970	626
1941–42	128	1971	640
1942–43	65	1972	767
1943–44	29	1973	1 258
1944	96	1974	1 026
1945	118	1975	789
1946	232	1976	1 040
1947	475	1977	714
1948	544	1978	2 720
1949	477	1979	1 776
1950	514	1980	732
1951	574	1981	592
1952	563	1982	591
1953	474	1983	544
1954	391	1984	340
1955	504	1985	270
1956	822	1986	253
1957	1 055	1987	210
1958	721	1988	193
1959	650	1989	292
1960	573	1990	200

Notes:
1. The 1931–1943 years are April–March but from 1944 onwards are calendar years.
2. The ‘QMA totals’ are approximations derived from port landing subtotals, as follows: SNA 7, Marlborough Sounds ports to Greymouth
3. Before 1946 the ‘QMA’ subtotals sum to less than the New Zealand total because data from the complete set of ports are not available.
4. Data up to 1985 are from fishing returns: data from 1986 to 1990 are from Quota Management Reports.
5. 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 include both foreign and domestic landings.

Table 2: Reported landings (t) of snapper from SNA 7 from 1983–84 to present and gazetted and actual TACCs (t) for 1986–87 to present. QMS data from 1986–present.

Fishstock	SNA 7	
FMAs	7	
	Landings	TACC
1983–84†	375	–
1984–85†	255	–
1985–86†	188	–
1986–87	257	330
1987–88	256	363
1988–89	176	372
1989–90	294	151
1990–91	160	160
1991–92	148	160
1992–93	165	160
1993–94	147	160
1994–95	150	160
1995–96	146	160
1996–97	162	160
1997–98	182	200
1998–99	142	200
1999–00	174	200
2000–01	156	200
2001–02	141	200
2002–03	187	200
2003–04	215	200
2004–05	178	200
2005–06	166	200
2006–07	248	200
2007–08	187	200
2008–09	205	200
2009–10	188	200
2010–11	206	200
2011–12	216	200
2012–13	211	200
2013–14	210	200
2014–15	210	200
2015–16	189	200
2016–17	263	250
2017–18	263	250
2018–19	257	250
2019–20	289	250
2020–21	337	350
2021–22	361	350
2022–23	518	450

† FSU data. SNA 7 = Statistical Areas 017, 033–036, 038

The SNA 7 TACC was increased in 2020–21 to 350 t and then increased to 450 t in 2022– 23 (Table 3). All commercial fisheries have a minimum legal size (MLS) for snapper of 25 cm.

Table 3: TACs, TACCs, and allowances (t) for SNA 7 from 1 October 2023.

Fishstock	TAC	TACC	Customary allowance	Recreational allowance	Other mortality
SNA 7	768	450	30	250	38

Foreign fishing

Japanese catch records and observations made by New Zealand naval vessels indicate that significant quantities of snapper were taken from New Zealand waters by Japanese vessels from the late 1950s until 1977. There are insufficient data to quantify historical Japanese catch tonnages for the respective snapper stocks. However, trawl catches have been reported by area from 1967 to 1977, and longline catches from 1975 to 1977 (Table 4). These data were supplied to the Fisheries Research Division of MAF in the late 1970s; however, the data series is incomplete, particularly for longline catches.

A substantial snapper catch was taken by the Japanese trawl fleet operating in the southern area of SNA 8 (South Taranaki Bight) adjacent to the northern SNA 7 boundary.

Table 4: Reported landings (t) of snapper and harvest within SNA 7 from 1967 to 1977 by Japanese trawl and longline fisheries.

Year	(a) Trawl	Trawl catch (all species)	Total snapper trawl catch	SNA 7
1967		3092	30	NA
1968		19 721	562	17
1969		25 997	1 289	251
1970		31 789	676	131
1971		42 212	522	115
1972		49 133	1 444	225
1973		45 601	616	117
1974		52 275	472	98
1975		55 288	922	85
1976		133 400	970	NA
1977		214 900	856	NA
Year	**(b) Longline**		**Total Snapper**	**SNA 7**
1975			1 510	–
1976			2 057	–
1977			2 208	–

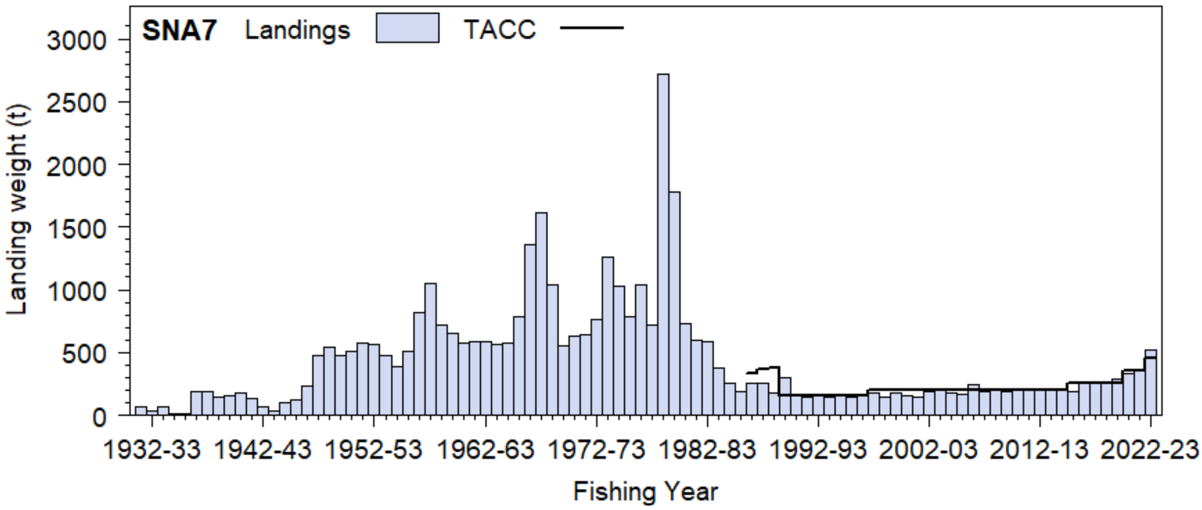


Figure 1: Total reported landings and TACCs for SNA 7.

1.2 Recreational fisheries

The snapper fishery is the largest recreational fishery in New Zealand. It is the major target species on the northeast and northwest coasts of the North Island and is targeted seasonally around the rest of the North Island and the top of the South Island. The current allowance within the SNA 7 TAC is shown in Table 3.

1.2.1 Management controls

The two main methods used to manage recreational harvests of snapper are minimum legal size limits (MLS) and daily bag limits. Both have changed over time (Table 5). The number of hooks permitted on a recreational longline was reduced from 50 to 25 in 1995.

Table 5: Changes to minimum legal size limits (MLS) and daily bag limits used to manage recreational harvesting levels in SNA 7.

Stock	MLS	Bag limit	Introduced
SNA 7	25	30	1/01/1985
SNA 7 (excl Marlborough Sounds)	25	10	1/10/2005
SNA 7 (Marlborough Sounds)	25	3	1/10/2005

1.2.2 Estimates of recreational harvest

A background to the estimation on recreational harvest of snapper is provided in the Introduction – Snapper chapter. Recreational harvest estimates for SNA 7 are provided in Table 6.

Plausible estimates for recreational catches from SNA 7 are available from the 1987 tagging programme, the aerial access surveys (in 2005–06 and 2015–16) and the national panel surveys (2011–12, 2017–18 and 2022–23). The estimates of recreational catch increased considerably from 2005–06 to 2017–18. The 2022–23 harvest estimate was similar to the previous (2017–18) estimate.

Most of the recreational catch has been recorded from Tasman Bay and Golden Bay. The catch is predominantly taken by rod-and-line, although a significant proportion of the catch was taken by longline during the mid 2010s. A small proportion of the total SNA 7 recreational catch was recorded from the Marlborough Sounds.

Boat ramp indices of snapper recreation catch have been developed from web cam monitoring at the main Nelson boat ramp. However, the indices are not considered to represent reliable indices of the snapper harvest for the entirety of SNA 7.

Table 6: Recreational catch estimates for SNA 7. Totals for a stock are given in bold. The telephone/diary surveys ran from December to November but are denoted by the January calendar year. Mean fish weights were obtained from boat ramp surveys (for the telephone/diary and panel survey catch estimates). Numbers and mean weights are not calculated in the tag ratio method. Amateur charter vessel (ACV) and recreational take from commercial vessels under s111 general approvals as reported, with Total the sum of NPS, ACV and s111. ACVs have only been required to report harvest for SNA since 2020–21.

			Harvest survey			ACV	s111	Total
Stock	**Year**	**Method**	**Number of fish (0000)**	**Harvest estimate (t)**	**CV**	**(t)**	**(t)**	**(t)**
SNA 7								
Tasman Bay / Golden Bay	1987	Tag ratio	–	**15**	–			
Total	1993	Telephone/diary	77	**184**	–			
Total	1996	Telephone/diary	74	**177**	–			
Total	2000	Telephone/diary	63	**134**	–			
Total	2001	Telephone/diary	58	**125**	–			
Total	2005–06	Aerial-access	–	**43**	**0.17**			
Total	2011–12	Panel survey	110	**88**	**0.17**	**0.4**	**1.7**	**90.3**
Total	2015–16	Aerial-access	–	**83**	**0.18**			
Total	2017–18	Panel survey	96	**144**	**0.16**	**1.0**	**13.4**	**158.5**
Total	2022–23	Panel survey	88	**130**	**0.14**	**7.6**	**1.6**	**139.0**

1.3 Customary non-commercial fisheries

There are no estimates of customary catch available for SNA 7. Current levels of customary catch in SNA 7 are considered to be small and are assumed to be included into recreational catch estimates.

1.4 Illegal catch

No new information is available to estimate illegal catch. For modelling in SNA 7 an assumption was made that non-reporting of catch was 20% of reported domestic commercial catch prior to 1986 and 10% of reported domestic commercial catch since the QMS was introduced. This was to account for all forms of under-reporting. These proportions were based on the black-market trade in snapper and higher levels of under-reporting (to avoid tax) that existed prior to the introduction of the QMS. The 10% under-reporting post-QMS accounts for the practice of 'weighing light' and the discarding of legal-size snapper.

1.5 Other sources of mortality

No estimates are available regarding the amount of other sources of mortality on snapper stocks; although high-grading of longline fish and discarding of under-sized fish by all methods occurs. An at-sea study of SNA 1 commercial longline fisheries in 1997 (McKenzie 2000) found that 6–10% of snapper caught by number were under 25 cm (MLS). Results from a holding net study indicate that mortality levels amongst lip-hooked snapper caught shallower than 35 m were low.

Estimates for incidental mortality were based on other catch-at-sea data using an age-length structure model for longline, trawl, seine, and recreational fisheries. In SNA 1, estimates of incidental mortality for the year 2000 from longlines were less than 3% and for trawl, seine, and recreational fisheries between 7% and 11% (Millar et al 2001). In SNA 8, estimates of trawl and recreational incidental mortality were lower, mainly because of low numbers of 2- and 3-year old fish estimated in 2000.

In SNA 1, recreational fishers release a high proportion of their snapper catch, most of which was less than 27 cm (recreational MLS). An at-sea study in 2006–07 recorded snapper release rates of 54.2% of the catch by trailer boat fishers and 60.1% of the catch on charter boats (Holdsworth & Boyd 2008). Incidental mortality estimated from condition at release was 2.7% to 8.2% of total catch by weight depending on assumptions used.

2. BIOLOGY

For further information on snapper biology refer to the Introduction – Snapper chapter. A summary of published estimates of biological parameters for SNA 7 is presented in Table 7.

There is evidence of changes in snapper growth rates in SNA 7 over the history of the fishery. Growth rates were estimated to be higher in the 1990s and 2000s than the earlier and more recent periods.

A length-based maturity ogive was derived from ovarian staging data collected from west coast North Island inshore trawl surveys. Female snapper mature from about 25 cm in length and reach full maturity at about 40 cm with 50% maturity at 35 cm.

Table 7: Estimates of biological parameters.

Fishstock	Estimate			Source
1. Instantaneous rate of natural mortality (*M*)				
SNA 1, 2, 7, & 8	0.075			Hilborn & Starr (unpub. analysis)
2. Weight = $a(\text{length})^b$ (Weight in g, length in cm fork length)				
All	a = 0.04467	b = 2.793		Paul (1976)
3. von Bertalanffy growth parameters				
	Both sexes combined			
	K	t_0	L_∞	
SNA 7 (1990s)	0.122	-0.71	69.6	MPI (unpub. data)
4. Age at recruitment (years)				
SNA 7	3*			MPI (unpub. data)

* Age at maturity in 2024 assessment based on ovarian sampling from WCNI trawl survey

A loss in genetic diversity has been associated with historical overfishing in SNA 7 (Bernal-Ramírez et al 2003).

3. STOCKS AND AREAS

New Zealand snapper are thought to comprise either seven or eight biological stocks based on: the location of spawning and nursery grounds; differences in growth rates, age structure, and recruitment strength; and the results of tagging studies. These stocks comprise three in SNA 1 (East Northland, Hauraki Gulf, and Bay of Plenty (BoP)), two in SNA 2 (one of which may be associated with the BoP stock), two in SNA 7 (Marlborough Sounds and Tasman Bay/Golden Bay) and one in SNA 8.

Tagging studies in SNA 7 (1986/87) and SNA 8 (1990) revealed reciprocal movements of snapper between Tasman Bay/Golden Bay and South Taranaki Bight (STB), although the scale of the movement was relatively low during that period.

Location-based snapper catch data from the trawl fisheries in SNA 7 and southern SNA 8 has revealed an overlap of the distribution of snapper catches in western approaches to Cook Strait between Durville Island and Kapiti Island, particularly since 2014/15. Snapper age compositions are available from recent (2018–2020 and 2022) *Kaharoa* trawl surveys of the South Taranaki Bight and the Tasman Bay/Golden Bay area of the WCSI trawl survey. There are strong differences in the relative strength of individual year classes from the 2019 South Taranaki Bight age composition compared to the 2018 and 2020 surveys, while the 2019 STB age composition was very similar to the age structures from the 2019 Tasman Bay/Golden Bay trawl survey and the commercial fishery in the TBGB area. These observations indicate a degree of mixing of the snapper populations between SNA 7 and the STB area (SNA 8), although the extent of mixing may vary between years, potentially related to variation in the timing of the main spawning period in each area.

The 2022 STB survey age composition was dominated by a very strong 5 yr age class, representing the 2017 year class. The 2017 year class was not present as a strong 3 yr age class in the previous (2020) survey, suggesting an immigration of snapper into the STB region. The year class appeared to be moderately strong in the 2018–2020 survey age compositions from the northern area of SNA 8 (at ages 1, 2 and 3 yr, respectively) but was not particularly strong in the 2022 survey age composition. The year class was observed to be very strong in Tasman Bay and Golden Bay when surveyed at 1, 3 and 5 years of age and represented the dominant age class in the 2022–23 age composition from the SNA 7 commercial fishery.

During 2022–23, catch sampling was conducted from the SNA 8 trawl fishery, partitioned between the northern and southern areas. The age composition of the commercial fishery in SBT was very similar to the age composition from the 2022 trawl survey with the dominance of the 5 yr age class. For the three fisheries, there were broad similarities in the relative proportion of fish in the older (greater than 9 years) age classes. A comparison of the average length at age from the three areas revealed that initial growth rates were faster for fish sampled from Tasman Bay and Golden Bay, while growth rates were similar between STB and northern SNA 8 up to age 5 years. For older age classes, the average length of age diverged between STB and northern SNA 8, with average length at age for STB approximating Tasman Bay and Golden Bay from about 7 years of age.

4. STOCK ASSESSMENT

An assessment for SNA 7 was conducted in 2015 and updated in 2018, 2020, 2021 and 2024.

SNA 7 (Challenger)

The SNA 7 fishery is concentrated within Tasman Bay and Golden Bay and this area is considered to represent the main spawning area and nursery area for the stock. Most of the main data sets included in the stock assessment were derived from the Tasman/Golden Bay area. However, since the mid 2010s there has been an increase in the spatial domain of the stock, particularly for older fish, with the distribution extending into deeper areas beyond TBGB (i.e., the western approaches to Cook Strait) and southward along the west coast of the South Island. It is currently assumed that fish in these areas migrate to spawn in the shallower areas of TBGB during late October-early December and disperse during late summer.

A stock assessment of SNA 7 was conducted in 2024. The assessment updated and refined the previous stock assessments conducted during 2015–2021 (see Langley 2021a). Those assessments were primarily based on a time series of CPUE indices from the SNA 7 trawl fishery, in addition to age compositional data from the trawl fishery and a tagging biomass estimate from 1987. The current stock assessment also incorporated the snapper biomass estimates, and the associated length and age compositions, from the time-series of *Kaharoa* inshore trawl surveys of west coast South Island and Tasman Bay/Golden Bay.

The 2024 stock assessment of SNA 7 was conducted using an age-structured population model implemented in Stock Synthesis. The model incorporated data to the 2023–24 fishing year (2023 model year) including:

- Commercial catches by method, 1931–2023;
- Recreational catches, 1931–2023;
- Tag biomass estimate 1987;
- Seasonal (Oct-Dec, Jan-Apr) single trawl CPUE indices 1989–2022;
- *Kaharoa* trawl survey biomass indices (1991–2022) and length/age compositions;
- Single trawl catch age compositions 1992–2022;
- Pair trawl catch age compositions 1975–1983; and
- Recreational catch length compositions 2005–2021.

Commercial catches

Commercial catch data are available for the SNA 7 fishery from 1931 to the 2022–23 fishing year. The model data set was configured to include three commercial fisheries: two seasonal single trawl fisheries (BT) in October-December (BT1) and January-September (BT2) and a pair trawl fishery (BPT). The SNA 7 catch taken by the purse-seine method during the late 1970s and early 1980s was assigned to the pair trawl fishery, as both methods are considered to harvest the full range of adult age classes in the population.

The seasonal division of the BT catch followed the derivation of separate seasonal CPUE indices and enabled the evaluation of different assumptions regarding the seasonal availability (selectivity) of snapper to the BT fisheries.

The reported commercial catches from 1931–1986 were increased by 20% to account for an assumed level of under-reporting. Since the introduction of the Quota Management System (QMS), the accuracy of the reporting of commercial catches has improved considerably, although a degree of under-reporting may persist. For 1987–2023, reported catches were increased by 10% to account for the assumed level of under-reporting in the more recent period. These assumptions are consistent with the formulation of the commercial catch histories incorporated in other inshore finfish stock assessments (based on assumptions for SNA 1 and SNA 8 made according to quota appeals when the QMS was first introduced).

The base assessment model initialised the model in 1975 under exploited conditions. This removed the influence of the earlier catches which are considered to be much less reliable than the more recent catches. The full catch history was retained in a model sensitivity that was initialised in 1931 assuming equilibrium, unexploited conditions.

Non-Commercial catches

The recreational catch history was constructed based on estimates of recreational catch from 1987, 2005–06, 2011–12, 2015–16, 2017–18 and 2022–23 (Figure 2). The point estimates were used to determine estimates of recreational exploitation rates in each year based on the annual estimates of biomass from preliminary model runs. Exploitation rates were interpolated between successive recreational catch estimates to determine annual estimates of recreational catch from 1987 to 2021. For the period prior to 1987, the exploitation rate was extrapolated, declining by 10% per annum, to the early 1960s when a lower threshold of 10 t per annum was attained. Length compositions from the recreational fishery (2005, 2011, 2015–2021) were derived from sampling conducted during boat ramp interviews.

Two options were assumed for the 2023–24 recreational catch: the catch was set equal to the 2022–23 harvest estimate (139.1 t) or was derived based on the average of the recreational fishery exploitation rates corresponding to the last three NPS harvest estimates (213 t).

There are no estimates of customary catch available for SNA 7. Recent customary catches are likely to have been a minor component of the total catch and are not explicitly included in the model catch history.

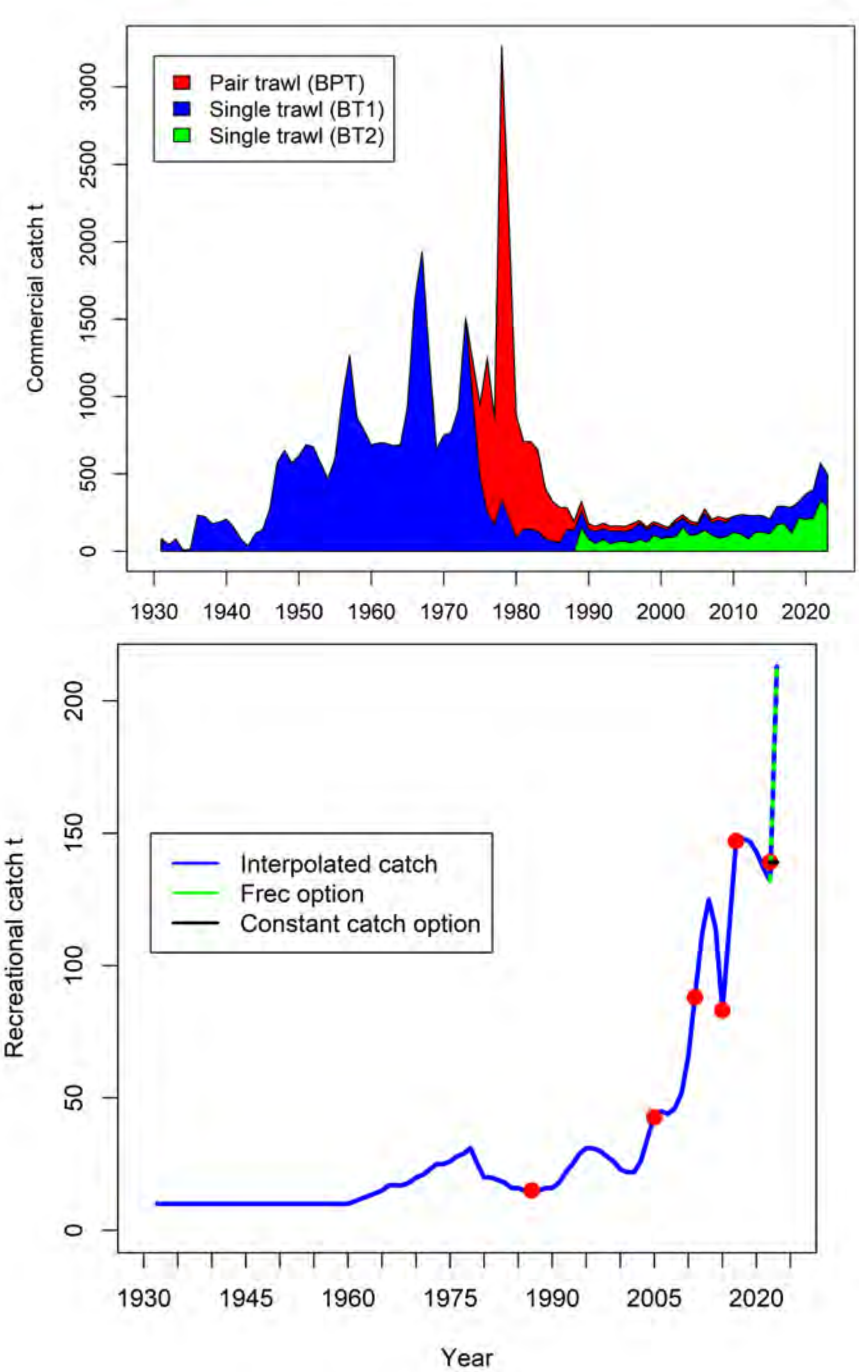


Figure 2: Commercial (top) and recreational (bottom) catch histories for SNA 7 included in the stock assessment models. The commercial catch history attributes all the single trawl catch prior to 1989 to the BT1 fishery. Commercial catches include an allowance for 20% unreported catch prior to the QMS and 10% allowance in the subsequent years. The red points represent the survey estimates of recreational catch. Only catches from 1975 onwards were included in the base assessment model.

Tagging biomass estimate

An estimate of 1987 stock biomass was derived from a tag release-recovery programme (Kirk et al 1988). A subsequent reanalysis of the tagging data yielded a very similar estimate of snapper biomass (1549 t) Harley & Gilbert (2000). Harley & Gilbert (2000) expressed concerns regarding the reliability of the 1987 tag biomass estimate due to spatial heterogeneity of tagged fish and the lack of tag releases in deeper water. Consequently, the tag biomass estimate was assigned a moderate level of precision (CV 30%).

CPUE indices

The previous stock assessments of SNA 7 incorporated a time series of CPUE indices as a primary index of stock abundance. The CPUE indices were based on catch and effort data from the Tasman Bay/Golden Bay trawl fishery targeting snapper, flatfish, red gurnard, and, to a lesser extent, barracouta during October–April. A detailed analysis of catch and effort data from the fishery indicated that since 2010–11 the operation of the trawl fishery had changed to increasingly avoid snapper, particularly during October–December. There was also some indication that the age composition of the snapper catch may vary between October–December and January–April. On that basis, separate sets of trawl CPUE indices were derived for the two seasons (BT1 and BT2). The analyses included catch and effort data from the 1989–90 to 2022–23 fishing years, aggregated by vessel fishing day. For each seasonal data set, a GLM approach was applied to separately model the probability of catching snapper (binomial model) and the magnitude of positive (non-zero) snapper catch (lognormal model) and the combined CPUE indices (delta-lognormal) were derived from the annual coefficients of the two models.

Due to the increase in snapper avoidance, the more recent (2010–2022) October–December (BT1) CPUE indices were not included in the assessment modelling.

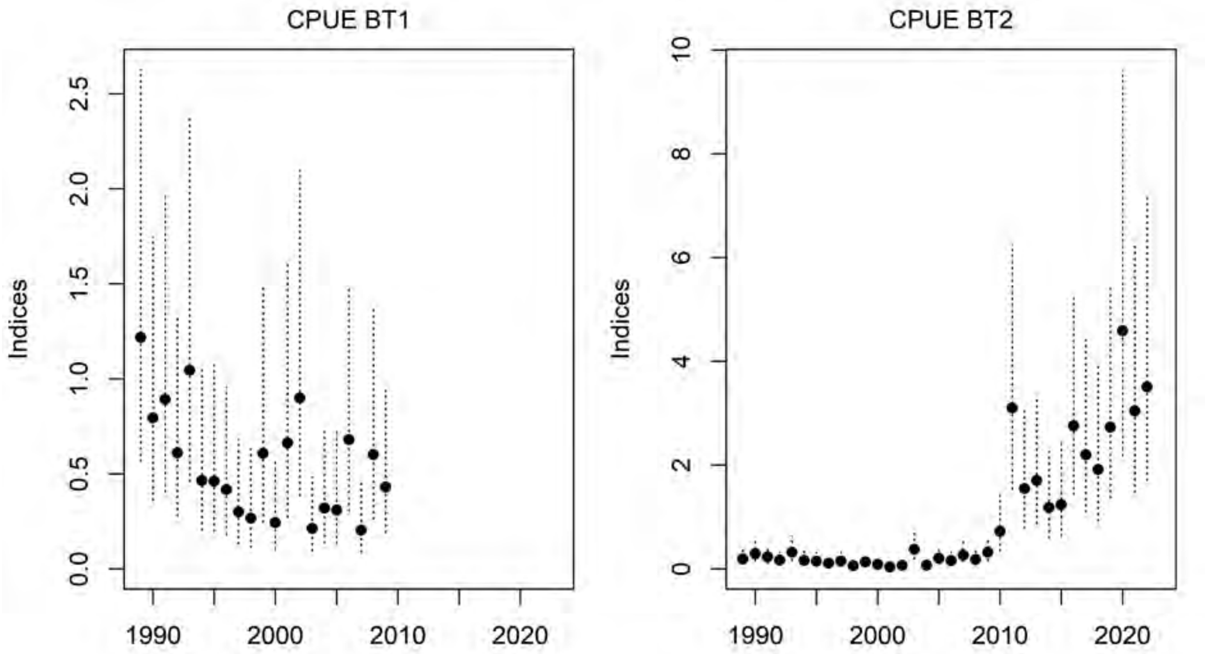


Figure 3: Relative CPUE indices derived from the delta lognormal (all years) model for the single trawl fishery during October-December (left) and January-April (right). The vertical lines represent the 95% confidence intervals. The confidence intervals were derived using a bootstrapping procedure.

The BT1 CPUE indices decline during the early 1990s and then remain at the lower level until 2010–11. The time series of BT2 CPUE indices are relatively constant during 1989–90 to 2009–10, increase initially in 2010–11 and then increase substantially in 2011–12. The indices fluctuate considerably about the higher level during the subsequent years (Figure 3). The scale of the variation in the BT2 CPUE indices may indicate a high degree of inter-annual availability of snapper within the TBGB area during summer/autumn.

Trawl survey

The West Coast South Island inshore trawl survey, including the Tasman Bay/Golden Bay area, commenced in 1992 and has been conducted biennially since 2002. The survey occurs in March–April coinciding with the period when larger, mature snapper are dispersing from TBGB following the spawning season. The survey area does not extend out into the deeper waters of the western approaches to Cook Strait but does include the west coast of the South Island extending from Farewll Spit in the north, as far as Haast in the south, in waters ranging from 20–400 metres for the core strata.

Prior to 2009, so few snapper were caught that the length frequency distribution was sparse and uninformative (MacGibbon et al 2024). Large numbers of 1+ snapper (around 14–19 cm) were caught on the 2009 survey (Stevenson & Hanchet 2010). This indicated that a strong year class of fish was spawned over the summer of 2007–08. This year class was dominant in the length frequency distribution from 2013 until about 2019 (MacGibbon 2019). Also visible were fish from the 2011 and 2013 year classes, which were also relatively strong (Parker et al 2015, Parsons et al 2018) and could be tracked through subsequent surveys. These strong year classes and the apparent increasing abundance of snapper in the Tasman Bay and Golden Bay region were the impetus for expanding the trawl survey area to include two new strata in 10–20 m, one in each of Tasman Bay and Golden Bay, beginning with the 2017 survey (Stevenson & MacGibbon 2018).

There was a conspicuous absence of 2+ fish between 22 and 29 cm in 2019 (Walsh et al 2019). Even with a 60 mm codend these fish would not likely have been caught as 0+ fish in the 2017 survey, and there was no survey in 2018 where they might have been caught as 1+ fish. Oddly however, the 2021 survey caught them as 4+ fish, though not in great numbers (MacGibbon et al 2022), and again as 6+ fish in 2023. This suggests that there may be some variability in the catchability of snapper to the survey. Since being introduced, the 10–20 m strata are where the majority of juvenile fish (under 25 cm) have been caught each year.

This expansion is now in its fourth year and the 2023 snapper biomass estimate for the expanded survey was the highest in the time series at 4404 t, almost three times the estimate from 2021 (the previous highest estimate) (MacGibbon et al 2024). At 3633 t, biomass in the core survey was more than four times the core estimate in 2021. Biomass increased in all strata in Tasman Bay and Golden Bay in 2023, but these were only modest increases for the 10–20 m strata. Stratum 17 (Golden Bay) saw a nearly twofold increase from 230 to 454 t, stratum 18 (Tasman Bay) increased more than 7-fold from 125 to 885 t, and stratum 19 increased more than 4-fold from 399 to 1606 t. Over the time series, core snapper biomass was low and showed a relatively flat trend until 2013, from which time there was a step increase to around 1000 t, before the massive increase in 2023. Biomass has increased every year in the core plus 10–20 m strata, especially in 2023.

More snapper biomass has come from Tasman Bay and Golden Bay than from the west coast, throughout the time series, including the period before the stock began to rebuild, when biomass was low in all areas (MacGibbon et al 2024). The west coast biomass increased in 2019, slightly decreased in 2021, and substantially increased in 2023 (by a factor of more than 5). As a proportion of the total, the biomass from the west coast in 2023 (16%) was more than in 2021 (8%), but similar to 2019 (14%).

The length frequency distribution for snapper from the west coast has typically been sparse compared with the distribution from Tasman Bay and Golden Bay and numbers were much lower (MacGibbon et al 2024). Fewer smaller fish were caught here and, apart from a very small number in 2009, no juveniles were caught off the west coast. Fish as large as those seen in Tasman Bay and Golden Bay were caught, albeit in much lower numbers. While still only a fraction of the number seen in Tasman Bay and Golden Bay, record numbers of fish were seen off the west coast in 2023.

Throughout the time series, juvenile fish have comprised only a small minority of the total biomass (MacGibbon et al 2024). The introduction of the 10–20 m strata in 2017 indicated that while these strata were important for juvenile snapper, most of the total biomass was adult fish.

Commercial age compositions

Commercial age frequency data are available from the TBGB BPT fishery from the pre QMS era (N=4) and BT from the QMS era (N=11). The annual BPT age compositions were derived from a small number of sampled landings. These data provide information regarding the age composition during the period of the highest catches from the fishery.

The more recent BT age compositions (2006, 2013, 2016, 2019 and 2022) were partitioned between the two seasons. In some years, a higher proportion of older fish were sampled from October–December (BT1) compared to January–April (BT2). This may indicate that older snapper are more available in TBGB during the main spawning period and subsequently disperse from the TBGB area over the following summer. The BT age compositions from the earlier years (1992, 1997–2000 and 2003) were assumed to represent the age composition of snapper from October–December (BT1), because most of the sampling took place during that period.

Model structure and assumptions

A statistical age-structured population model for SNA 7 was implemented using Stock Synthesis (Methot & Wetzell 2013). A summary of input data, fixed and estimated parameters are provided in Tables 8, 9 and 10. The main model structural assumptions for the base model are as follows:

- The initial population (1975) was initialised under exploited conditions and was configured as a single sex model comprised of 30 age classes, including a plus group. The model data period is 1975–2023 (the 2023 model year represents the 2023–24 fishing year) and includes two seasons (October-December and January-September). The initial age structure was derived by estimating an equilibrium fishing mortality rate and recruitment deviations for the initial age structure (1960–1974 year classes).
- The estimation of the initial equilibrium fishing mortality ratewas informed by a prior (normal, mean 0,2, sd=0.1). The prior was required to stabilize the estimation of the initial F and recruitment parameters. The prior did not influence the estimate of absolute biomass for the period after 1980.
- Annual recruitments for 1975–2021 were estimated as unconstrained deviates from a Beverton-Holt stock-recruitment relationship (SRR) with steepness of 0.95. Recruitment for 2022–23 was assumed based on the average level of recruitment from the recent period (2010–2019).
- Commercial fisheries (BPT, BT1 and BT2) selectivities are age-based and temporally invariant. The three fisheries have full selection for all recruited age classes (parameterised using a logistic selectivity function).
- Age based selectivity for the *Kaharoa* trawl survey (core area) was parameterised using a logistic selectivity function. Temporal variation in the selectivity (a50) was estimated for the trawl surveys from 2012–13 to 2022–23 to account for an apparent increase in the availability of younger fish.
- The age compositions from the 2018, 2020, 2022 core + SNA survey area were considered to represent estimates of the full population age structure (i.e., selectivity 1.0 for all age classes). This assumption was required to adequately inform the model regarding the relative abundance of the youngest age classes (1–4 y) in conjunction with the longer time series of data from the *Kaharoa* trawl survey (core area). Model trials that estimated the selectivity function for the core + SNA survey resulted in a comparable selectivity function.
- The selectivity of the recreational fishery is length-based and parameterised using a double normal function. Selectivity is configured with three time blocks (pre-2013, 2013–2015, and 2016 onwards) to account for the increase in the catch of larger fish by the longline method in the intermediate period and increased targeting of larger fish in more recent years.
- The two sets of CPUE indices (BT1 and BT2) were assigned additional process error of 30% and 20%, respectively, based on RMSE from preliminary model runs. Similarly, the *Kaharoa* trawl survey (core area) biomass indices were assigned process error of 20%.
- The tag biomass estimate was assumed to represent the proportion of the stock biomass that had recruited to the commercial BPT fishery in 1987. The tag biomass estimate was assigned a CV of 30% following Harley & Gilbert (2000). The moderate CV was adopted to reflect concerns regarding the reliability of the tag biomass estimate.
- The relative weighting of the individual commercial age compositions were assigned based on the MWCV of the observations. The final relative weightings (ESS) of the BT1, BT2 and BPT age compositions were determined following the approach of Francis (2011). The two sets of trawl survey age compositions were each assigned an ESS of 50 to ensure that these data were informative in the model estimation of recent recruitments.

- The recreational length compositions were also assigned an ESS of 1.0, as they may not fully represent the fishery, and the selectivity of the recreational fishery appears to have changed over time.
- Growth rates of snapper in TBGB were variable over the model period with higher growth of younger fish occurring during 1990–2009. The model was divided into three periods (pre-1990, 1990–2009 and post-2009), based on these observed differences in growth rates. The length-at-age data from each period was used to estimate time specific values of the *k* VB growth parameter. The time-specific growth functions were applied to the three time periods of the model.

Table 8: Summary of input data sets for the Base Case assessment model. The relative weighting includes the Effective Sample Size (ESS) of age/size composition data and the coefficient of variation (CV) associated with the abundance data. Note that model year 2022, is fishing year 2022–23, and includes the trawl survey conducted in March 2023.

Data set	Model years	Nobs	Error structure	Observation error/ESS	Process error
Tag biomass	1987	1	Lognormal	0.30	–
BT1 CPUE indices	1989–2009	21	Lognormal	0.09–0.16	0.3
BT2 CPUE indices	1989–2022	34	Lognormal	0.14–0.20	0.2
Trawl survey Core indices	1991, 1993, 1994, 1996, 1999, 2002, 2004, 2006, 2008, 2010, 2012, 2014, 2016, 2018, 2020, 2022	16	Lognormal	0.13–0.94	0.2
Trawl survey Core age comp	2016, 2018, 2020, 2022	4	Multinomial	ESS 50	
Trawl survey Core length comp	2008, 2010, 2012, 2014	4	Multinomial	ESS 10	
Trawl survey Core+SNA age comp	2018, 2020,2022	3	Multinomial	ESS 50	
BT1 age comp	1992, 1997–2000, 2003, 2006, 2013, 2016, 2019, 2022	11	Multinomial	ESS 20	
BT2 age comp	2006, 2013, 2016, 2019, 2022	5	Multinomial	ESS 10	
BPT age comp	1978–1980, 1983	4	Multinomial	ESS 18	
Recreational length comp	2005, 2011, 2015–2021,	9	Multinomial	ESS 1	

Table 9: Details of parameters that were fixed in the base model.

Natural mortality	0.075 y^{-1}
Stock-recruit steepness (Beverton & Holt)	0.95
Std deviation of rec devs (sigmaR)	1.5
Proportion mature (female, length-based logistic)	L50% = 35 cm, L5% 26 cm, L95% 44 cm
Length-weight [mean weight (kg) = a (length (cm))^b]	$a = 3.61 \times 10^{-5}$, $b = 2.8644$
Growth parameters	$L_\infty = 69.6$, Length1=13.1
pre-1990 (1), 1990-2009 (2), post- 2009 (3)	*k1*=0.098, *k2*=0.122, *k3*=0.103,
Coefficients of variation for length-at-age	0.075

Table 10: Estimated parameters for the base model.

Parameter	Number of parameters	Parameterisation, priors, constraints
LnR_0	1	Uniform, uninformative
Initial equilibrium F	1	Normal(0.2,0.1)
Initial Rec devs (1960–1974)	15	SigmaR 1.5
Rec devs (1975–2021)	47	SigmaR 1.5
Selectivity BPT commercial	2	Logistic
Selectivity BT1 commercial	2	Logistic
Selectivity BT2 commercial	5	Logistic
Selectivity trawl survey core	8	Logistic
Selectivity trawl survey core+SNA	-	Constant
Selectivity tag	–	Equivalent to commercial BPT
Selectivity Recreational	8	Double normal
CPUE BT1 *q*	1	Uniform, uninformative
CPUE BT2 *q*	1	Uniform, uninformative
Trawl Survey *q*	1	Uniform, uninformative

For the base model option, the model biomass approximates the point estimate of the 1987 recruited biomass from the tagging programme (Figure 4). The model also provides a good fit to the time series of BT2 CPUE indices to 2010. Stock biomass is predicted to have increased considerably from 2010 (2010–11 fishing year) following the overall magnitude of the increase in trawl survey biomass indices and BT2 CPUE indices. However, the fits to the individual BT2 CPUE indices from 2011–12 to 2022–23 are relatively poor (Figure 4). The fit to the BT1 CPUE indices (1989–2009) is poor (Figure 4).

The model provides a good fit to the time-series of trawl survey biomass indices, with the exception of the 2022 index. The model estimate of the vulnerable trawl survey biomass is approximately half of the observed biomass index. A range of model options were investigated to endeavour to fit the high recent biomass index. None of those options provided credible results as they substantially degraded the fit to the other recent data sets.

The initial increases in the CPUE and trawl survey biomass indices are consistent with the recruitment of the very strong 2007 year class (Figure 5). This year class dominated the age compositions from the trawl fishery and (core) trawl survey during 2013–14 to 2018–19. More recent age compositions were augmented by the recruitment of subsequent year classes, most notably the 2010 year class. The 2018–19 and 2020–21 trawl surveys (core + SNA) yielded relatively high catch rates of juvenile snapper in the shallower TBGB strata (10-20 m), which dominated the associated age compositions. Correspondingly, the model estimated exceptionally strong 2017 and 2018 year classes. These year classes also dominated the recent (2022–23) age compositions sampled from the commercial fishery. The most recent (2022–23) trawl survey indicated that recent (2019–2021) recruitments were low.

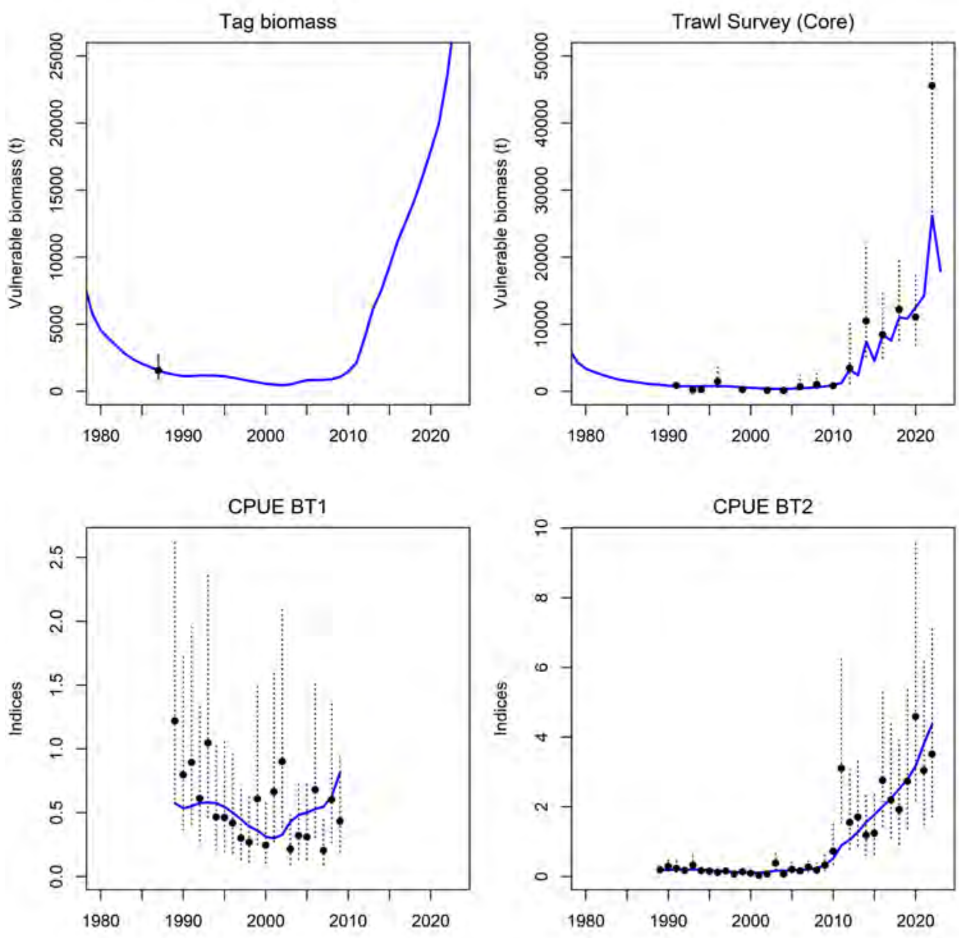


Figure 4: Biomass trajectories (MPD) for the base model option presenting the fit to the tag biomass estimate (top left panel), trawl survey (core) biomass indices (top right panel) and the CPUE indices (lower panels).

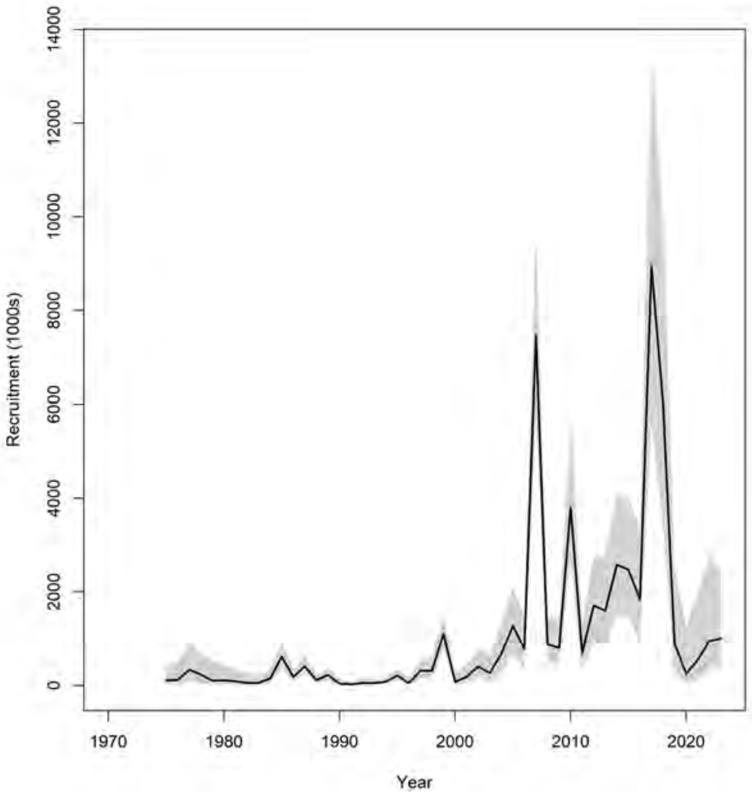


Figure 5: Annual recruitment for the base model (MCMC results). The main recruitment deviates were estimated for 1975–2021. The line represents the median and the shaded area represents the 95% credible interval.

A range of model trials was conducted to investigate the relative influence of the individual data sets. These trials revealed that estimates of recent biomass were relatively insensitive to the relative weighting of the CPUE indices and trawl survey biomass indices and age compositions. The increasing trend in stock biomass was driven by the recent BT2 CPUE indices; the trawl survey biomass indices were less informative due to the higher variability (and lower frequency) of the series.

The base model provides estimates of current stock status that are quite uncertain, primarily due to the uncertainty associated with the estimates of the strength of recent recruitment (2017 and 2018 year classes). There is also uncertainty associated with the scale of the increase in stock abundance due to differential trends in the increase of the two principal abundance indices and the associated assumptions regarding fishery/survey selectivities. A range of model sensitivities was undertaken to investigate model assumptions, these included a lower value of natural mortality (0.06 compared with 0.075), a lower value of variation in the recruitment deviates (sigmaR 1.1 compared with 1.5), alternative parameterisation of the recruitment deviates, a lower value of steepness (0.85) and the removal of time varying selectivity of the trawl survey (Table 11). In addition, a model option incorporated additional snapper catch from South Taranaki Bight (FMA 8) to consider a wider spatial definiton of the stock. The sensitivities were generally treated as single changes from the base model. A full catch history model, initialising the unexploited equilibrium population in 1931, was retained for comparison with the structure of the previous (2022) assessment.

Table 11: Description of model sensitivities.

Sensitivity run	Description
NatMort sensitivity	$M = 0.06$
RecDev variation sensitivity	sigmaR = 1.1
RecDev vector	Constrained rec dev vector
Steepness sensitivity	$h = 0.85$
Init 1975 (Pseudo Fishery) sensitivity	Alternative initialisation of model in 1975
Trawl Survey selectivity sensitivity	Temporally invariant trawl survey selectivity
Stock structure sensitivity	Include FMA 8 catches
Full catch history sensitivity	Initialise model in 1931, unexploited equilibrium conditions, rec devs 1960–2021.

Stock status was determined for 2023 (= 2023–24 fishing year) relative to the interim target fishing mortality level, i.e., $U_{SB40\%}$. the default value for a low productivity stock as described by the Harvest Strategy Standard. Spawning biomass was assessed relative to hard and soft biomass limits proposed by the INS WG (see Derivation of Reference Points – below).

B, biomass is estimated to have increased considerably from 2010. Current (2023) biomass is well above (%) the soft limit (Figure 6, Table 12). For all model options, current rates of fishing mortality are well below the corresponding exploitation rate based target ($U_{SB40\%}$) (Figure 7, Table 12).

For all model options, estimates of current yield were derived for the stock based on the target fishing mortality rate ($U_{SB40\%}$). $U_{SB40\%}$ yields at 2023–24 biomass levels are about 1800 t, well above the level of current catch (626 t or 708 t), which includes commercial catch, other sources of mortality and recreational catch. The higher biomass and yield for the *FMA8catch* sensitivity reflects the addition of the southern SNA 8 catches encompassed in the model.

Table 12: Estimates of current (2023–24) spawning biomass (t) and fishing mortality relative to $U_{SB40\%}$ (median and the 95% confidence interval from the MCMCs) and the probability of being below the target $U_{SB40\%}$. Estimates of current yield (t) at $U_{SB40\%}$ at the 2023–24 biomass levels are also provided.

Model	SB_{2023}	$U_{SB40\%}$	$U_{2023}/U_{SB40\%}$	$Pr(U_{2023} < U_{SB40\%})$	**Yield** $U_{SB40\%}$
Base_RecCatch	13 816	5.1%	0.376	1.00	1 872
	(9 810–18 530)		(0.278–0.532)		(1 313–2 537)
Base_Frec	13 154	5.0%	0.453	1.00	1 778
	(9 293–18 241)		(0.322–0.633)		(1 239–2 517)
FMA8catch	21 623	5.1%	0.32	1.00	2 958
	(16 312–29 671)		(0.232–0.428)		(2 194–4 089)
LowM	14 567	4.4%	0.417	1.00	1 687
	(10 624–19 567)		(0.309–0.566)		(1 236–2 329)
PseudoFishery	13 624	5.1%	0.381	1.00	1 841
	(9 587–20 087)		(0.252–0.542)		(1 283–2 821)
RecDevVector	13 915	5.1%	0.373	1.00	1 881
	(9 683–19 529)		(0.262–0.53)		(1 309–2 678)
SigmaR11	11 457	5.0%	0.457	1.00	1 541
	(8 482–15 625)		(0.335–0.622)		(1 116–2 117)
Steepness85	13 976	4.8%	0.393	1.00	1 788
	(10 051–19 517)		(0.282–0.551)		(1 248–2 516)
TSurveySelect	15 096	5.0%	0.33	1.00	2 192
	(11 046–20 961)		(0.237–0.458)		(1 558–3 094)
start1931	13 212	5.0%	0.401	1.00	1 759
	(9 477–18 338)		(0.283–0.57)		(1 222–2 527)

Projections

Projections were conducted for the base model with two options for recreational catches: constant annual catch equivalent to the 2022–23 recreational harvest estimate (131 t) (*RecCatch*) or a constant recreational fishing mortality (the average of the last three recreational harvest estimates) (*RecF*). Stock projections were conducted for the 5-year period following the terminal year of the model (i.e., 2024–2028). Projections assumed future recruitments were resampled from the lognormal distribution around the geometric mean of recent recruitments. Commercial catches in the projection period were held constant at the current TACC of 450 t with an allowance for additional mortality of 45 t. There was no explicit allowance for customary catch.

The projections are strongly influenced by the high estimates of recent recruitment of the 2017 and 2018 year classes, resulting in an increase in total biomass during the projection period (Figure 6). Successive recent surveys and commercial age composition data have reaffirmed that these year classes are very strong although the magnitude of the year classes is uncertain.

For the base case (and all other model options), stock abundance is predicted to continue to increase in the projection period and fishing mortality remains well below the target level ($F_{SB40\%}$ level) throughout the projection period (Table 13). Under the constant fishing mortality assumption, recreational catches are projected to increase in proportion to the overall increase in stock biomass.

Table 13: Annual commercial (set at TACC, including an additional 10% unreported) and recreational catches (assumed or predicted) for the last three years of the model period and the five-year projection period (shaded) from the *RecF* and *RecCatch* models. The annual stock status ($F_{year}/F_{SB40\%}$ and SB_{year}/SB_{2023}) for the projection period is also presented for both model options (with associated 95% confidence intervals).

Year	Commercial catch (t)	Recreational catch (t)		SB_{year}/SB_{2023}		$F_{year}/FSB40\%$	
		RecF	*RecCatch*	*RecF*	*RecCatch*	*RecF*	*RecCatch*
2021–22	495	161	161				
2022–23	495	131	131				
2023–24	495	213	131				
2024–25	495	230	131	1.14	1.14	0.44	0.35
		(123–353)		(1.10–1.18)	(1.11–1.18)	(0.34–0.57)	(0.26–0.51)
2025–26	495	237	131	1.24	1.25	0.41	0.33
		(120–370)		(1.18–1.32)	(1.18–1.34)	(0.33–0.54)	(0.24–0.48)
2026–27	495	240	131	1.31	1.33	0.40	0.32
		(112–382)		(1.22–1.42)	(1.23–1.45)	(0.31–0.53)	(0.23–0.46)
2027–28	495	242	131	1.36	1.38	0.39	0.30
		(110–394)		(1.25–1.50)	(1.26–1.53)	(0.28–0.52)	(0.22–0.45)
2028–29	495	249	131	1.39	1.41	0.38	0.29
		(111–405)		(1.26–1.56)	(1.28–1.58)	(0.26–0.51)	(0.21–0.44)

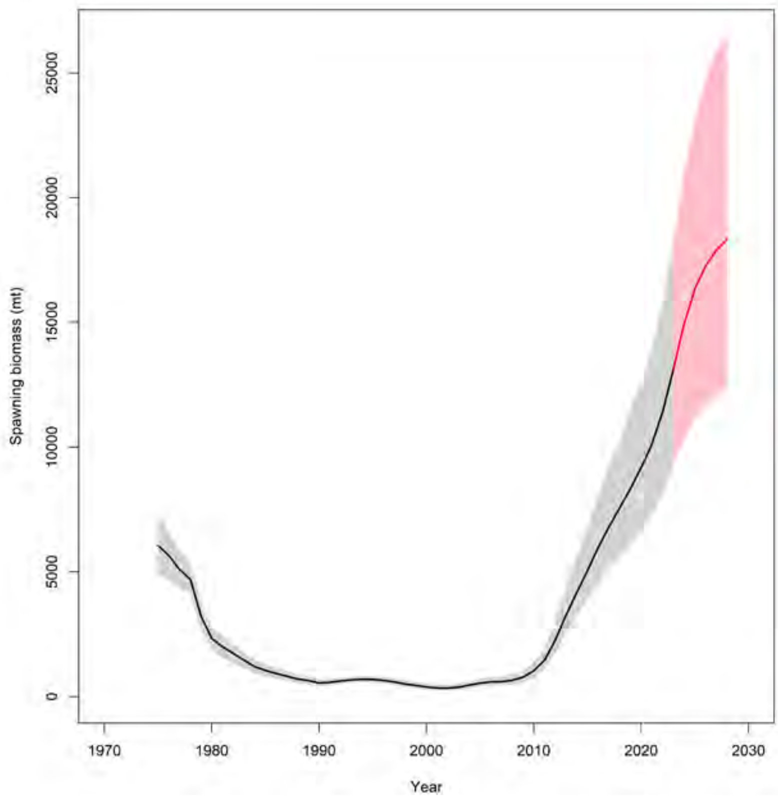


Figure 6: Annual trend in spawning biomass for the base model. The line represents the median and the shaded area represents the 95% confidence interval. The projection period (2024–2028) is in red (*RecF* option).

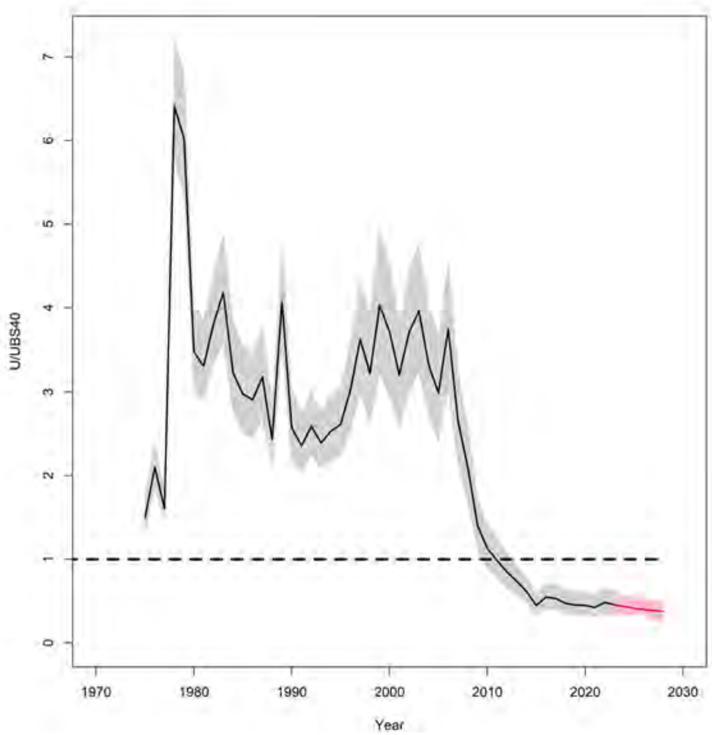


Figure 7: Annual trend in fishing mortality relative to the $U_{SB40\%}$ interim target biomass level for the base model. The line represents the median and the shaded area represents the 95% credible interval. The projection period (2024–2029) is in red (*RecF* option). The dashed line represents the interim target level.

Derivation of Reference Points

Substantial increases in annual recruitment suggested an increase in productivity, and possibly a regime shift, for SNA 7. Owing to the complexities associated with estimating SB_0 under these circumstances, the Inshore Working Group made the decision to base the target reference point on exploitation rate instead of biomass as a proportion of SB_0. Consistent with international best practice the hard and soft limits were based on absolute biomass.

The default target accepted for SNA 7 was the exploition rate that, if applied perfectly over the long term and assuming equilibrium recruitment, would produce a spawning biomass of 40% of that in the absence of fishing ($F_{SB40\%}$; U=5%).

After considerable discussion on options for deriving biomass based hard and soft limits the WG agreed that the hard limit should be twice the 1987 spawning biomass estimate. This year followed a large decline in biomass following peak catch from the fishery and preceded a stable but very low biomass period that previous assessments had suggested was well below the default HSS hard limit of 10%B0. The 1987 tagging study biomass estimate is for vulnerable biomass and is fitted perfectly by the current model. The stock assessment spawning biomass estimate from the base case biomass trajectory is used for establishing the hard limit. The soft limit is twice the biomass of the hard limit. The 2024 May Plenary supported this approach for setting the hard limit, but recommended future review if new information becomes available.

Qualifying comments

The 1987 tag biomass estimate is considered to be an underestimate of the total recruited biomass due to the relatively small proportion of older fish estimated to be in the tagged fish population. However, model testing, either excluding or increasing the tag biomass estimate, has indicated that the assessment is relatively insensitive to the tag biomass estimate, especially with the assumed level of precision (CV 30%).

For the earlier assessments, the main abundance indices were CPUE indices derived for the entire fishing season (October-April). Subsequent analyses revealed increasing avoidance of snapper by the trawl fleet since 2010, especially during the spawning season (October-December). For the current assessment, the main set of CPUE indices was derived for January-April. The degree of avoidance of snapper is likely to be considerably less during this period. Nonetheless, it is considered that the main CPUE indices are also likely to underestimate the extent of the increase in snapper abundance from 2010 onwards. There is, however, a general correspondence between the increase in the CPUE indices and the abundance indices from the *Kaharoa* trawl survey.

The increased avoidance of snapper has included changes in the configuration of the trawl gear over the last 3–5 years, including a reduction in the headline height to reduce the catch of snapper, particularly larger fish. The overall effect of this change in gear configuration has not been quantified but it may have resulted in a change in the selectivity of the trawl fishery, particularly for older fish. This effect has not been incorporated in the assessment modelling.

The CPUE indices are derived for the Tasman Bay and Golden Bay fishery only. There has been an expansion of the range of snapper over the last 10 years, especially southward along the west coast of the South Island. The recent WCSI inshore trawl survey indicated that about 19% of the snapper biomass was off the west coast of the South Island in March of 2023. The disproportional increase in the stock in this area is not reflected in the CPUE abundance indices.

The time-series of core area trawl survey biomass indices was included in the stock assessment. This component of the survey does not adequately monitor the younger (1–4 years old) snapper which are predominantly found within the shallower areas (<20 m) of Tasman Bay and Golden Bay not included in the core survey area.

The older fish in the population (greater than 10 years) do not appear to be fully available to the trawl survey, at least in some years. The trawl survey occurs during late summer and older fish may have already dispersed to areas outside the survey area, following spawning in November-December. There are significant catches of snapper taken within SNA 7 outside of the trawl survey area, i.e., in the deeper areas in the western approaches to Cook Strait. The distribution of older snapper may also extend into the southern areas of SNA 8 (South Taranaki Bight and Kapiti coast). The proportion of the older fish within the survey area may vary between years depending on the timing of the dispersal of larger snapper from Tasman Bay/Golden Bay. The most recent survey age composition was poorly fitted in the assessment models and, correspondingly, the selectivity function for the trawl survey is not well estimated, particularly for the older age classes.

Recent (2017) modifications of the trawl survey design to include the shallower areas of Tasman Bay/Golden Bay (SNA strata) have improved the utility of the survey for monitoring of SNA 7, particularly for younger (1–4 year old) fish. However, the limited number of observations (3 surveys) meant that there were insufficient data to reliably estimate the selectivity for snapper within the shallower area separately from the core area. Therefore, the inclusion of two sets of age compositions (core and core+SNA strata) in the assessment model duplicated the age composition data from the core survey area, effectively doubling the influence of these data in the assessment model. Down-weighting these two data sets in the model likelihood resulted in an overall improvement in stock status. The trawl survey age composition data were informative due to the lower proportion of older snapper from the 2020–21 survey, particularly relative to the age composition from the October-December trawl fishery.

The most recent trawl surveys have reaffirmed the presence of the very strong 2017 and 2018 year classes, while the more recent year classes (2019–2021) are relatively weak.

Future research considerations

Trawl surveys

- The modified WCSI RV *Kaharoa* survey (extra snapper strata in Tasman and Golden Bays) is monitoring the abundance and age composition of younger (1–4 year old) snapper enabling

recent recruitments to be estimated in the stock assessment model and should be continued on the current biennial basis.
- Consideration around extending the current trawl survey to include the South Taranaki Bight and Kapiti area to improve monitoring of the snapper in the wider area that are potentially part of the same stock. Currently, this area is monitored by the WCNI trawl survey which is conducted in October-November and may not monitor the portion of snapper migrating to spawn in Tasman/Golden Bay. Correspondingly, some of those fish that spawned in Tasman/Golden Bay will not be monitored by the current March-April trawl survey.
- Explore alternative approaches to incorporating data from the new TB/GB snapper strata into the assessment, including accounting for selectivity differences.

Age sampling of commercial catches
- A cycle for two consecutive years in five is recommended for SNA 7 shed sampling. Sampling should be stratified by area and season (and possibly target species) to enable a comparison between the age structure of catches from the spawning and post spawning periods and potential differences in age structure related to fishing depth. Sampling of the west coast South Island trawl fishery should be maintained.
- The current programme of concurrent sampling of SNA 7 and SNA 8 (particularly the south Taranaki region) will enable further evaluation of the connectivity between the two QMAs. This should be continue in future.

CPUE analysis
- Improved spatial and seasonal modelling of CPUE data from SNA 7 and southern SNA 8 to improve understanding of movement between areas.
- Development of CPUE indices to account for changes in the spatial distribution of snapper (e.g. using VAST).
- Explore changes in fishing operations related to increased avoidance or preferential targeting of snapper to qualify the utility of CPUE indices for the monitoring of trends in snapper abundance.
- Investigate splitting the vessels with long time series into two or more pseudo vessels.

Recreational harvest estimates
- Recreational fishing has accounted for significant proportion of the total catch from SNA 7. In addition to the NPS, there should be ongoing sampling of the recreational catch of snapper from boat ramps; such data also need to be analysed in more detail. Boat ramp data may also provide the opportunity to collect additional size composition data from the recreational fishery, which could be used to derive age compositions.
- At presently there is only monitoring of the Nelson boat ramp and consideration should be given to monitoring additional ramps, e.g., Golden Bay and Motueka.

Assessment model structure
- Changes in stock abundance and age composition over the last decade appear to have expanded the stock distribution, with older fish now extending down the west coast of the South Island and probably into South Taranaki Bight. These changes may be influencing seasonal availability to the fishery and trawl survey, and more complex assessment model structure should be considered to model seasonal availability and selectivity (potentially interacting with density).
- Possibly develop a spatially structured model that includes SNA 7 and relevant parts of SNA 8.
- Develop an overfishing threshold that is higher than the exploitation rate target.

Stock structure
- Continue to review available data and explore additional data sources to inform stock structure assumptions.

Harvest Control Rule

- Develop a harvest control rule that requires the exploition rate to decline below the target as spawning biomass approaches the soft limit, e.g., akin to the Harvest Strategy Standard default.

Environmental drivers of recruitment

- Further investigation should be conducted to identify correlations between snapper recruitment and key environmental variables to improve our understanding of snapper recruitment dynamics.

Mean age at length

- Evaluate fit of VB functions to age data and if there are issues consider alternative means of representing mean age at length.

Tagging study

- Undertake a tagging study (in association with SNA 8) to estimate biomass, seasonal movement, stock boundaries, and selectivity.

5. STATUS OF THE STOCKS

Stock Structure Assumptions

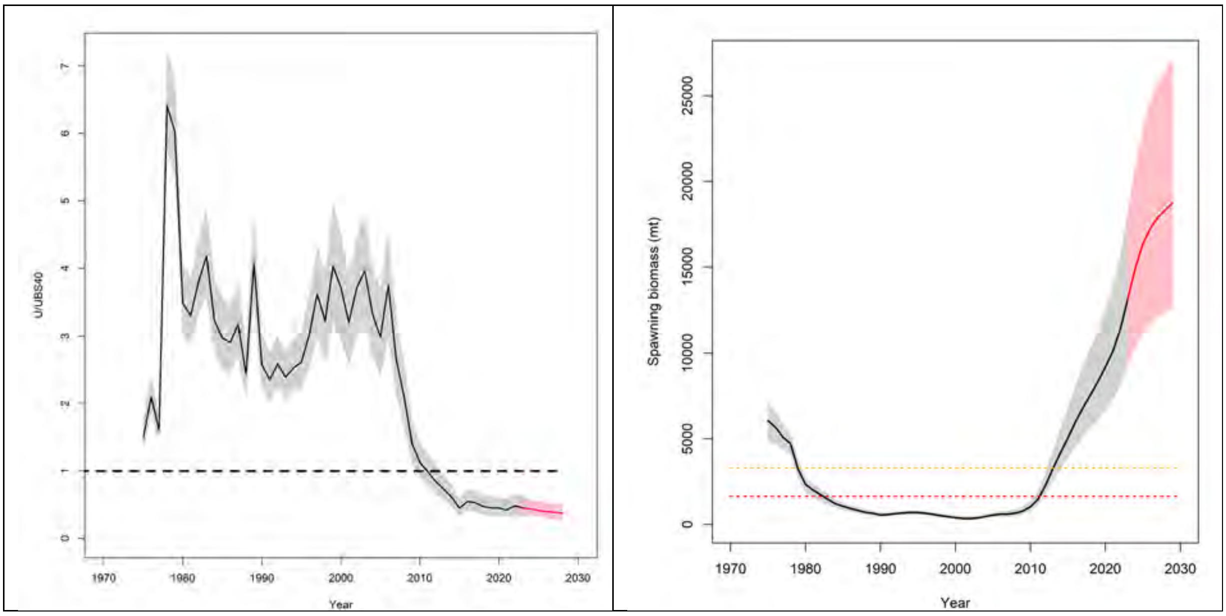
New Zealand snapper are thought to comprise either seven or eight biological stocks based on the location of spawning and nursery grounds, differences in growth rates, age structure, and recruitment strength, and the results of tagging studies. These stocks are assumed to comprise three in SNA 1 (East Northland, Hauraki Gulf, and Bay of Plenty), two in SNA 2 (one of which may be associated with the Bay of Plenty stock), two in SNA 7 (Marlborough Sounds and Tasman/Golden Bay/west coast South Island), and one in SNA 8. Tagging studies reveal that limited mixing occurs between the three SNA 1 biological stocks, with the greatest exchange between the Bay of Plenty and Hauraki Gulf.

- **SNA 7**

The assessment is for the Tasman Bay, Golden Bay, and west coast South Island stock unit of SNA 7. The Marlborough Sounds is considered to support a separate stock of snapper within SNA 7, but catches, although minor, are included in the SNA 7 assessment model.

Stock Status		
Most Recent Assessment Plenary Publication Year	2024	
Catch in most recent year of assessment	Year: 2023–24	Catch: 708 t (TACC 450 t, additional mortality 45 t, *F* based recreational estimate 213 t)
Assessment Runs Presented	Base case model	
Reference Points	Interim target ; $U_{SB40\%}$= 5% Soft Limit: Twice the biomass of hard limit. Hard Limit: Twice 1987 spawning biomass estimate. Overfishing threshold: $U_{SB40\%}$	
Status in relation to Target	Very Likely (> 90%) to be at or below the target.	
Status in relation to Limits	Soft Limit: Exceptionally Unlikely (< 1%) to be below Hard Limit: Exceptionally Unlikely (< 1%) to be below	
Status in relation to Overfishing	Overfishing is Very Unlikely (< 10%) to be occurring	

Historical Stock Status Trajectory and Current Status



Annual exploitation rate (relative to $U_{SB40\%}$)(left) and base model *SSB* trajectory (right) for the period since 1975 (dotted line indicates target $U_{SB40\%}$ exploitation rate). Projections (*RecF*) are in red. The line represents the median and the shaded area represents the 95% credible interval. The red and orange dashed lines represent the hard and soft limits, respectively.

Fisheries and Stock Trends	
Recent Trend in Biomass or Proxy	Biomass was at an historical low level in the early 2000s and increased substantially from 2009, initially due to the recruitment of several strong year classes. Biomass has continued to increase following recruitment of recent (2017 and 2018) very strong year classes.
Recent Trend in Fishing Intensity or Proxy	Fishing mortality declined steadily from 2006 to 2015, and has remained well below the overfishing threshold since then.
Other Abundance Indices	- The Spring/Summer CPUE series (BT1), although assumed to be biased low and not used in the assessment after 2010, also shows a substantial increase. - CPUE from the west coast South Island trawl fishery has increased substantially over the last 10 years.
Trends in Other Relevant Indicators or Variables	- The increase in recreational catch estimates from 2005 onwards suggests that abundance has increased. - Increased abundance of snapper in areas adjacent to SNA 7, i.e South Taranaki Bight.

Projections and Prognosis	
Stock Projections or Prognosis	Projections (5 yr) are provided based on recent (2010–11 to 2019–20) average recruitment. Biomass is projected to continue to increase at the level of the current TACC and projected recreational catch.
Probability of Current Catch or TAC causing Biomass to remain below or to decline below Limits	Soft Limit: Exceptionally Unlikely (< 1%) Hard Limit: Exceptionally Unlikely (< 1%)
Probability of Current Catch or TAC causing Overfishing to continue or to commence	Exceptionally Unlikely (< 1%)

Assessment Methodology and Evaluation		
Assessment Type	Level 1 – Full Quantitative Stock Assessment	
Assessment Method	Age-structured Stock Synthesis model with MCMC estimation	
Assessment Dates	Latest assessment Plenary publication year: 2024	Next assessment: 2026
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	- Commercial catch history (1983 onwards)	1 – High Quality
	- Commercial catch history (1975-1983)	2 – Medium or Mixed Quality: catches are considered to be less reliable
	Tagging biomass estimate	2 – Medium or Mixed Quality: whether the older ages are indexed by the tagging study is uncertain
	- CPUE indices	1 – High Quality
	- Historical commercial age frequency	2 – Medium Quality: needs to be better characterised by method of capture
	- Recent commercial age frequency	1 – High Quality
	- Recreational catch history (2005 onwards)	1 – High quality
	- Recreational catch history (preceding period)	2 – Medium or Mixed Quality: historical levels of recreational catch are assumed
	- *Kaharoa* WCSI trawl survey biomass indices (core area)	1 – High Quality
	-Trawl survey age compositions (2016, 2018, 2020, 2022)	1 – High Quality
	-Trawl survey length compositions (2008–2016)	1– High Quality
Data not used (rank)	BT1 (October to December) CPUE index post 2010	3 – Low Quality: potentially biased low due to recent avoidance of spawning aggregations
	West coast inshore bottom trawl CPUE	3 – Low Quality: potentially hypostable
Changes to Model Structure and Assumptions	- Initialise model in 1975 under exploited conditions, including prior on initial equilibrium fishing mortality and initialising recruitment deviates (1960–1974). - Recruitment deviates estimated (from 1975) as simple deviates (i.e. not constrained to an average of one). - Updated recreational catch history incorporating recent recreational catch estimate (2022–23). Alternative assumptions for future recreational catches. - Increased weighting on early (1970s, early 1980s) BPT age compositions. - Increased age-at-maturity based on ovarian sampling from WCNI trawl survey. Individual sample sizes for each observation of BT1 and BT2 age composition series. - Parameterisation of trawl survey selectivity (time varying logistic).	

	- Process error included for trawl survey biomass indices.
Major Sources of Uncertainty	- Strength of recent recruitment (2017 and 2018 year classes) - Reliability of CPUE indices, as could be biased low due to snapper avoidance since 2015. - Historical and projected levels of recreational catch - Availability of older (10+ yr) snapper to the trawl survey - Connectivity between SNA 7 and southern SNA 8

Qualifying Comments
The stock structure relationship with the South Taranaki Bight portion of SNA 8 is unclear.

Fisheries Interactions
Snapper target fisheries have a bycatch of flatfish, red cod, gurnard, tarakihi, and small amounts of barracouta and blue warehou. Snapper is taken as a bycatch of the inshore trawl fisheries operating within FMA 7, particularly within Tasman Bay and Golden Bay. Since 2013–14, most (> 80%) of the snapper catch has been taken as a bycatch of those fisheries.

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