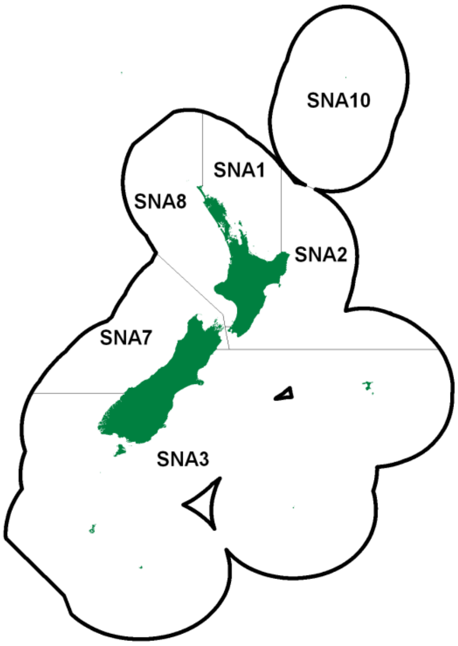
# SNAPPER (SNA 7)

(*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 |

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

The SNA 7 TACC was increased in 2020–21 to 350 t (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 2020.**

| Fishstock | TAC | TACC | Customary allowance | Recreational allowance | Other mortality |
|---|---|---|---|---|---|
| SNA 7 | 645 | 350 | 20 | 250 | 25 |

## 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 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 | – |

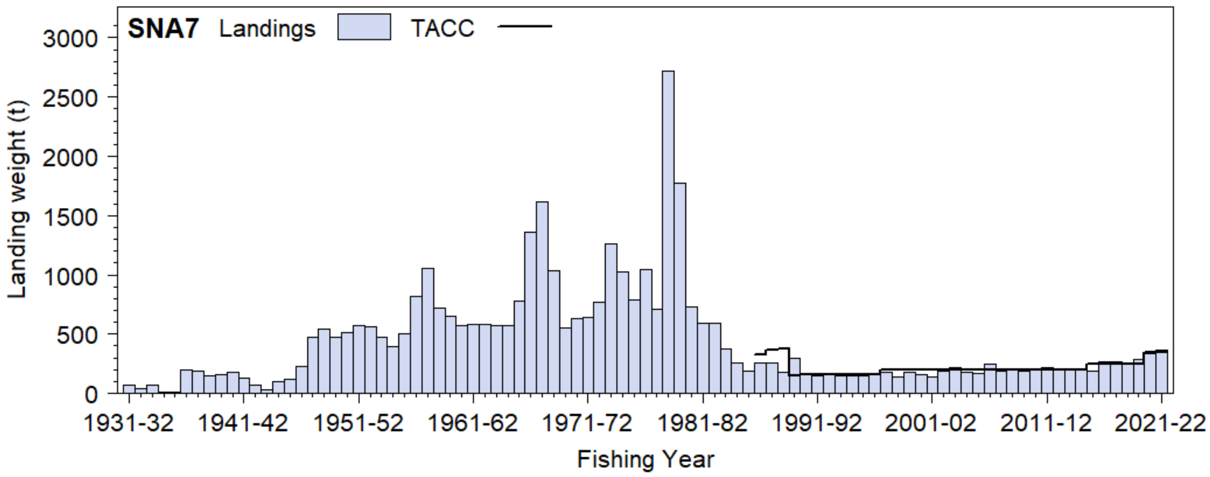



**Figure 1: Total reported landings and TACCs for SNA 7.**

## 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 and 2017–18). The estimates of recreational catch increased considerably from 2005–06 to 2017–18.

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.

**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. 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 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 | **89** | **0.17** |
| Total | 2015–16 | Aerial-access | – | – | **83** | **0.18** |
| Total | 2017–18 | Panel survey | 98 | 1 505 | **147** | **0.16** |

[3] Mean weight obtained from 1995–96 boat ramp sampling.
[5] The 2000 mean weights were used in the 2001 estimates.

## 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.

**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 | | | |
| | $K$ | $t_0$ | $L_\infty$ | |
| SNA 7 (1990s) | 0.122 | -0.71 | 69.6 | MPI (unpub. data) |
| 4. Age at recruitment (years) | | | | |
| SNA 7 | 3 | | | MPI (unpub. data) |

## 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, 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. STOCK ASSESSMENT

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

## 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 2021. The assessment updated and refined the previous stock assessments conducted during 2015–2020 (see Langley 2020a). 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 2021 stock assessment of SNA 7 was conducted using an age-structured population model implemented in Stock Synthesis. The model incorporated data to the 2020–21 fishing year (2020 model year) including:

- Commercial catches by method, 1931–2020;
- Recreational catches, 1931–2020;
- Tag biomass estimate 1987;
- Seasonal (Oct-Dec, Jan-Apr) single trawl CPUE indices 1989–2019;
- *Kaharoa* trawl survey biomass indices (1991–2020) and length/age compositions;
- Single trawl catch age compositions 1992–2019;
- Pair trawl catch age compositions 1974–1983; and
- Recreational catch length compositions 2005–2019.

### Commercial catches

Commercial catch data are available for the SNA 7 fishery from 1931 to the 2019/20 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 1987–2020, 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).

### Non-Commercial catches

The recreational catch history was constructed based on estimates of recreational catch from 1987, 2005–06, 2011–12, 2015–16, and 2017–18 (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 2016. The 2018–19 recreational catch was estimated using the 2017–18 exploitation rate. 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, 2015–2019) were derived from sampling conducted during boat ramp interviews.

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.

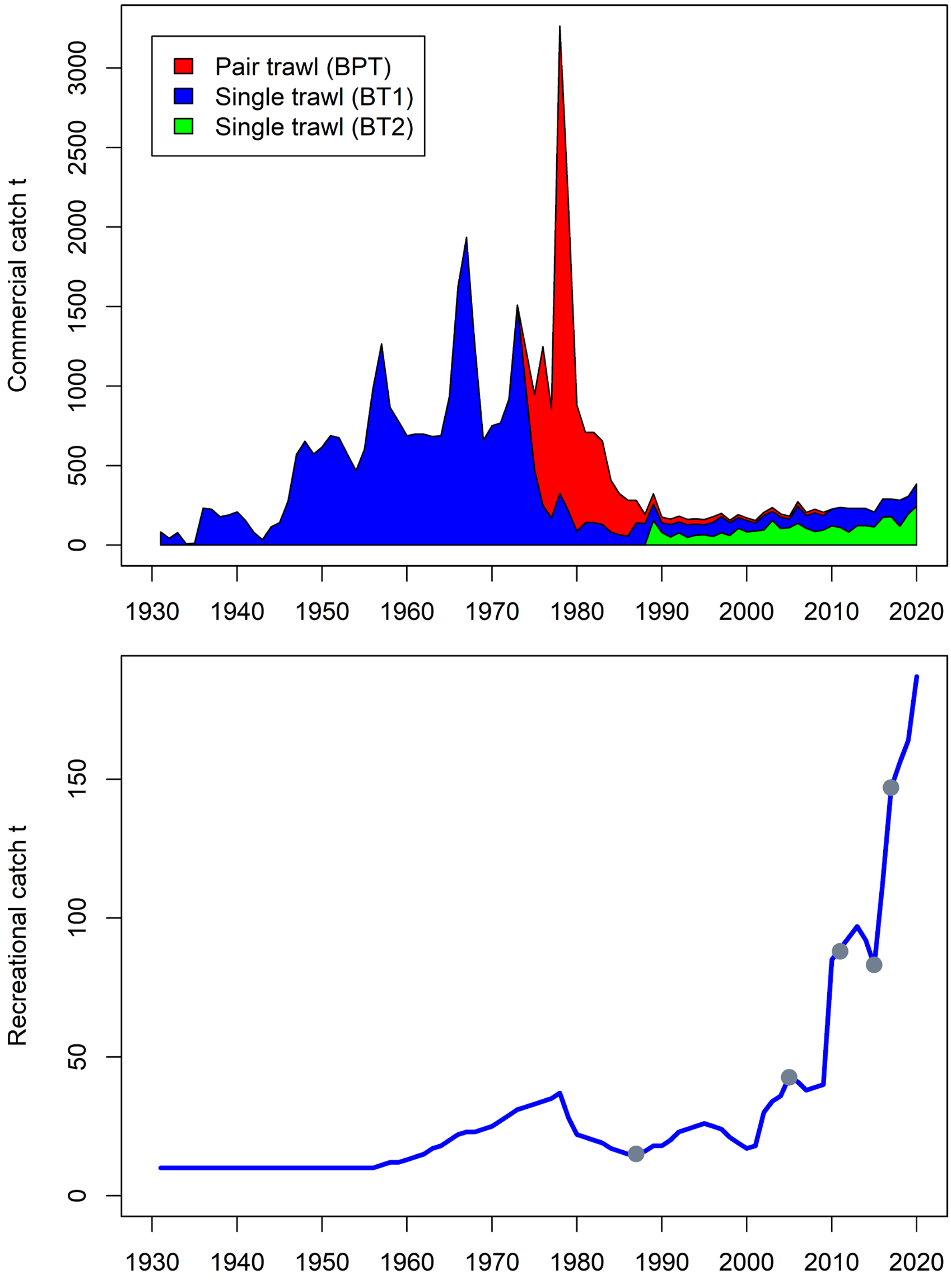



**Figure 2: Commercial (top) and recreational catch histories for SNA 7 included in the stock assessment models. The commercial catch history attributes all the single trawl catch prior to 1989 to the BT1 fishery. Commercial catches include an allowance for 20% unreported catch prior to the QMS and 10%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

**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 2019–20 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 (2010–2019) October–December (BT1) CPUE indices were not included in the assessment modelling.

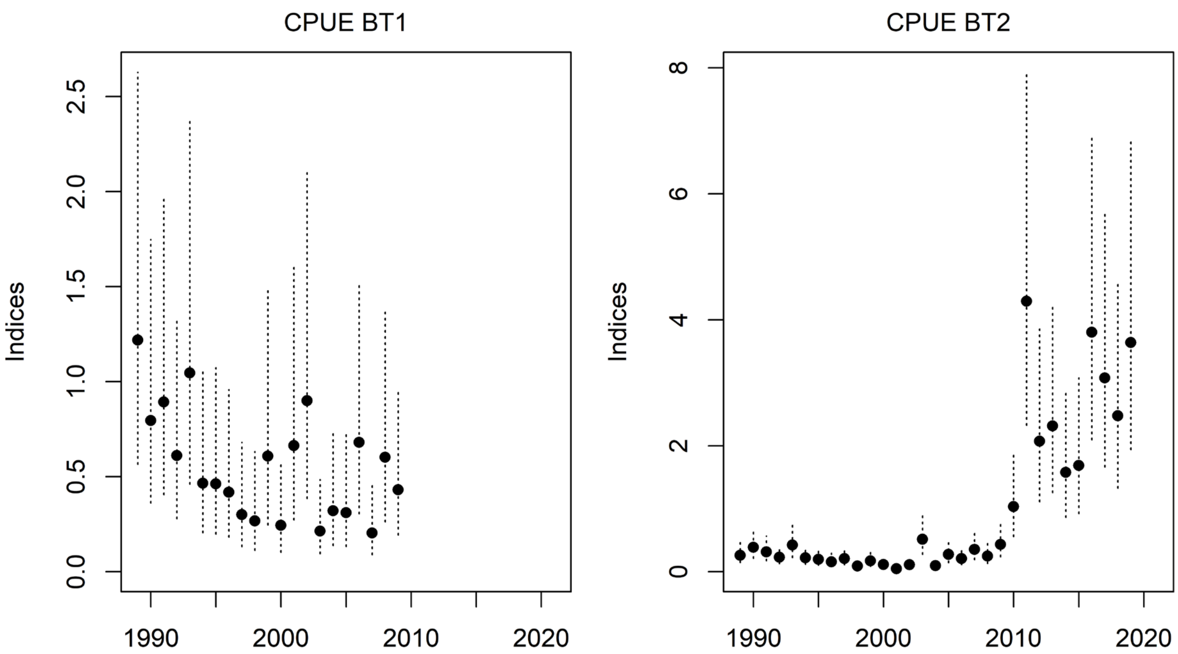



**Figure 3: Relative CPUE indices derived from the delta lognormal (all years) model for the single trawl fishery during October-December (left) and January-April (right). The vertical lines represent the 95% confidence intervals. The confidence intervals were derived using a bootstrapping procedure.**

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 increased substantially in 2011–12. The indices fluctuated 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 beyond TBGB (western approaches to Cook Strait).
Prior to 2017, the trawl survey area did not include the shallower areas (less than 20 m) of TBGB. This area has accounted for a considerable proportion of the snapper catch and also includes the main nursery areas for snapper within SNA 7. From 2017, surveys were extended to include designated "snapper" strata within the shallower area (10–20 m) of TBGB, extending the overall survey area from the original "core" strata.

Snapper biomass indices were derived for the core strata (TBGB and WCSI) for the time-series of trawl surveys. The biomass indices are very low from 1992–2011 and increase considerably in 2013 and 2015 and remain at the higher level for the three subsequent surveys. Since 2019, a larger proportion of the survey biomass was composed of snapper from the northern area of the west coast of the South Island, principally composed of older fish.

Length compositions were derived for each survey (core area) from 2009 onwards; insufficient snapper were sampled from the earlier trawl surveys to derive reliable length compositions. Age compositions are available from the three most recent trawl surveys (2017, 2019 and 2021). The 2017 and 2019 trawl surveys were dominated by two strong year classes, whereas the 2021 (core) trawl survey was dominated by younger snapper (age 2-6 yr).

The "core" survey biomass indices and length/age compositions were included in the stock assessment model. The data suggest a lower availability of older fish to the trawl survey, probably due to the dispersal of those fish into areas outside the core survey area. Consequently, the trawl survey selectivity function was parameterised to allow for the estimation of lower selectivity of the older age classes.

For the shallow TBGB snapper strata, there was a substantial increase in snapper biomass from the three recent surveys (2017, 2019 and 2021). The time-series of biomass indices was considered too short for inclusion in the stock assessment, although the age composition data from this portion of the survey are considered to provide the best available information regarding recent recruitments. The 2019 trawl survey (core + SNA) age composition was dominated by 1-year old fish, indicating strong recent recruitment (the 2017 year class). While the 2021 survey was dominated by 2- and 3-year old fish, indicating the presence of another strong year class (2018) and reaffirming the strength of the 2017 year class (age 3-yr).

The recent increase in the abundance of juvenile snapper (in the "snapper" strata) appears to have coincided with an increase in the availability of young (age 4–5 yr) snapper to the "core" trawl survey for the recent surveys, as indicated by the increased proportion of the young snapper in the area deeper than 20 m. This may indicate that the selectivity of younger snapper has increased for the core survey in recent years.

**Commercial age compositions**
Commercial age frequency data are available from the TBGB BPT fishery from the pre QMS era (N=5) and BT from the QMS era (N=10). The annual BPT age compositions were derived from a small number of sampled landings. The data were down-weighted in the final assessment model due to deficiencies in the initial fits that indicated that the strength of individual year classes was poorly determined from these data.

The more recent BT age compositions (2006, 2013, 2016 and 2019) 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 (1931) is in an unexploited, equilibrium state configured as a single sex comprised of 30 age classes, including a plus group. The model data period is 1931–2020 (the 2020 model year represents the 2002–21 fishing year) and includes two seasons (October-December and January-September),
- Recruitment for 1931–1974 is at the equilibrium level (with a Beverton-Holt stock-recruitment relationship, SRR, steepness of 0.95); recruitment deviates are estimated for 1975–2019. Recruitment for 2020 was assumed based on the average level of recruitment from the stock-recruitment relationship.
- Commercial fisheries selectivities are age-based and temporally invariant.
- Selectivities for the commercial BPT and BT1 fisheries have full selection for all recruited age classes (parameterised using a logistic selectivity function). The selectivity for the BT2 fishery is parameterised using a flexible, double-normal function.
- Age based selectivity for the *Kaharoa* trawl survey (core area) was parameterised using a double-normal selectivity function. Temporal variation in the age of the peak in selectivity was estimated for the three most recent trawl surveys (2016/17, 2018/19 and 2020/21) to account for an apparent increase in the availability of younger fish.
- The age compositions from the 2018 and 2020 core + SNA survey area were fitted with a separate double-normal 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.
- 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 weightings (ESS) of the BT1, BT2 and trawl survey age compositions were determined following the approach of Francis (2011); the BT1 and BT2 age compositions were assigned an Effective Sample Size (ESS) of 20, while the two sets of trawl survey age compositions were each assigned an ESS of 50.
- The BPT age compositions were assigned a low relative weighting (ESS = 1); sufficient weight to inform the model about the fishery selectivity, while not strongly influencing the estimates of year class strength. Similarly, 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 2020, is fishing year 2020/21, and includes the trawl survey conducted in March 2021.**

| 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 | 1989–2019 | 31 | Lognormal | 0.09–0.15 | 0.2 |
| Trawl survey Core indices | 1991, 1993, 1994, 1996, 1999, 2002, 2004, 2006, 2008, 2010, 2012, 2014, 2016, 2018, 2020 | 15 | Lognormal | 0.13–0.94 | – |
| Trawl survey Core age comp | 2016, 2018, 2020 | 3 | Multinomial | ESS 50 | |
| Trawl survey Core length comp | 2008, 2010, 2012, 2014 | 4 | Multinomial | ESS 10 | |
| Trawl survey Core+SNA age comp | 2018, 2020 | 2 | Multinomial | ESS 50 | |
| BT1 age comp | 1992, 1997–2000, 2003, 2006, 2013, 2016, 2019 | 10 | Multinomial | ESS 20 | |
| BT2 age comp | 2006, 2013, 2016, 2019 | 4 | Multinomial | ESS 20 | |
| BPT age comp | 1974, 1978–1980, 1983 | 5 | Multinomial | ESS 1 | |
| Recreational length comp | 2005, 2011, 2015–2019, | 7 | 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 | 0 for ages 1–2, 1 for ages > 2 |
| Length-weight [mean weight (kg) = $a$ (length (cm))$^b$] | $a$ = 3.61 × 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 |
|---|---|---|
| Ln$R_0$ | 1 | Uniform, uninformative |
| Rec devs (1975–2019) | 45 | SigmaR 1.5 |
| Selectivity BPT commercial | 2 | Logistic |
| Selectivity BT1 commercial | 2 | Logistic |
| Selectivity BT2 commercial | 5 | Double normal |
| Selectivity trawl survey core | 8 | Double normal |
| Selectivity trawl survey core+SNA | 5 | Double normal |
| 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 and provides a good fit to the time-series of trawl survey biomass indices (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 2019–20 are relatively poor (Figure 4). The fit to the BT1 CPUE indices (1989-2009) is poor (Figure 4).

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 have been 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, although the magnitude of these recruitment estimates is uncertain.

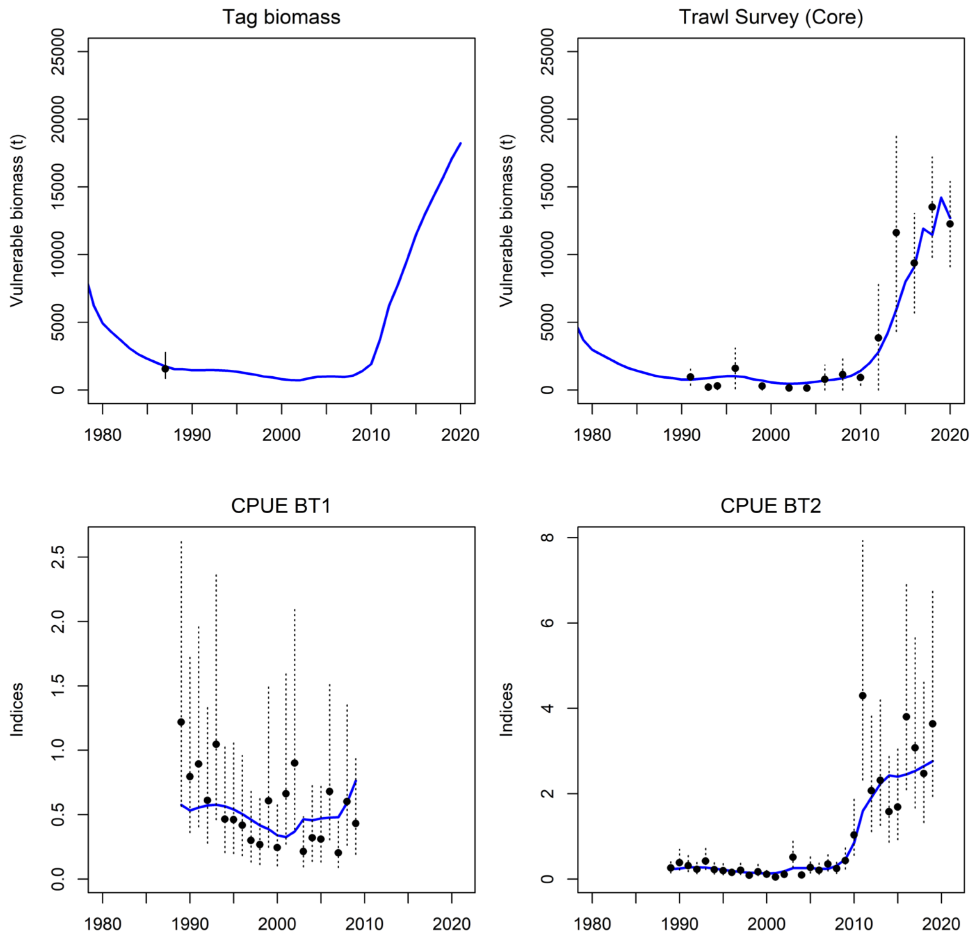



**Figure 4: Biomass trajectories (MPD) for the base model option presenting the fit to the tag biomass estimate (top left panel), trawl survey (core) biomass indices (top right panel) and the CPUE indices (lower panels).**

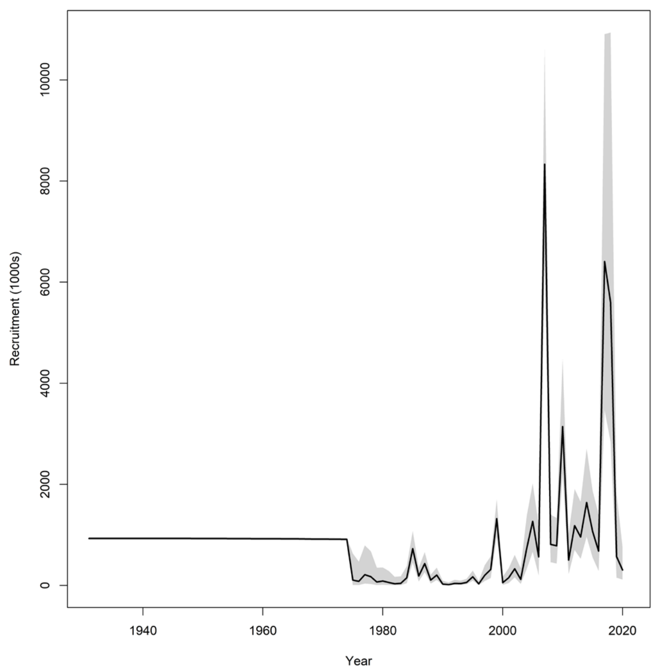



**Figure 5: Annual recruitment for the base model (MCMC results). Recruitment deviates were estimated for 1975–2019. The line represents the median and the shaded area represents the 95% credible interval.**

The model fits to individual age compositions from the recent years were relatively poor, indicating a degree of conflict between the 2020/21 trawl survey age composition and the trawl survey biomass and BT2 CPUE indices. 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, although less emphasis on the trawl survey age compositions yielded more optimistic estimates of stock status.

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 year class). 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 were undertaken to investigate model assumptions, these included a lower value of natural mortality (0.06 compared with 0.075), an older age of sexual maturity (5 yr compared to 3 yr), a lower value of variation in the recruitment deviates (sigmaR 1.0 compared with 1.5), no allowance for unreported catches and a suite of models contrasting the influence of the CPUE indices and the trawl survey biomass indices and the age composition data from the trawl survey (Table 11). The sensitivities were generally treated as single changes from the base model.

**Table 11: Description of model sensitivities.**

| Sensitivity run | Description |
|---|---|
| NatMort sensitivity | $M = 0.06$ |
| RecDev variation sensitivity | sigmaR = 1.0 |
| Mature5yr | Knife-edge maturity at age 5 yr |
| CPUE indices | Exclude trawl survey biomass indices |
| Trawl Survey indices | Exclude CPUE indices |
| BPT age comp | Higher weighting on BPT age comp (ESS 10)<br>Estimate rec devs 1950-2019 |
| Trawl Survey Age down-weight | ESS = 5 for trawl survey age comps |
| UnreportedCatchZero | No unreport catch pre- and post QMS |

Stock status (current 2020 = 2020/21 fishing year and forecast to 2025/26) for the SNA 7 spawning biomass was reported relative to the default hard limit of 10% $SB_0$ and the default soft limit of 20% $SB_0$ and interim target biomass level of 40% $SB_0$. Fishing mortality (2020) was reported relative to the corresponding interim target biomass level, i.e., $F_{SB40\%}$. The interim target biomass level was proposed at the SINS WG and was based on the default value for a low productivity stock as described by the Harvest Strategy Standard.

For the base model, biomass is estimated to have increased considerably from 2010 and the current (2020) biomass is well above the interim target biomass level (40% $SB_0$) (Figure 6, Table 12). The range of model sensitivities all estimated levels of current stock status above the interim target biomass level.

For all model options, current rates of fishing mortality are well below the corresponding fishing mortality threshold ($F_{SB40\%}$) (Figure 7, Table 12).

For all model options, estimates of current and equilibrium yield were derived for the stock based on the fishing mortality rate that corresponds to the interim target biomass level (Table 13). Equilibrium yields at the interim target biomass level are estimated to be about 600–700 t per annum. $F_{SB40\%}$ yields at 2020–21 biomass levels are comparable to the yields at 40% $B_0$. Current $F_{SB40\%}$ potential yields are at or above the level of current catch (572 t), which includes commercial catch, other sources of mortality and recreational catch.

**Table 12: Estimates of current (2020–21) and virgin spawning biomass (t) (median and the 95% confidence interval from the MCMCs) and probabilities of current biomass being above specified levels and probability of fishing mortality being below the level of fishing mortality associated with the interim target biomass level.**

| Model option | $SB_0$ | $SB_{2020}$ | $SB_{2020}/SB_0$ | Pr($SB_{2020}$ > X% $SB_0$) | | |
|---|---|---|---|---|---|---|
| | | | | 40% | 20% | 10% |
| **Base** | 15 999 (15 583-16 486) | 10 047 (7 385-13 342) | 0.628 (0.464-0.825) | 0.996 | 1.000 | 1.000 |
| LowM | 16 825 (16 467-17 184) | 8 970 (6 759-11 683) | 0.533 (0.408-0.69) | 0.980 | 1.000 | 1.000 |
| Mature5yr | 15 719 (15 217-16 155) | 8 800 (6 511-11 774) | 0.561 (0.415-0.743) | 0.983 | 1.000 | 1.000 |
| Model_CPUE | 15 994 (15 532-16 465) | 8 014 (5 659-11 172) | 0.502 (0.354-0.697) | 0.895 | 1.000 | 1.000 |
| Model_TrawlSurvey | 15 868 (15 434-16 297) | 8 710 (6 237-12 434) | 0.551 (0.395-0.77) | 0.973 | 1.000 | 1.000 |
| Model_BPTage | 20 242 (18 063-22 879) | 11 150 (5 516-15 711) | 0.548 (0.291-0.75) | 0.935 | 0.982 | 0.986 |
| SigmaR1.0 | 15 666 (15 185-16 157) | 9 723 (7 338-13 133) | 0.622 (0.472-0.826) | 0.998 | 1.000 | 1.000 |
| TrawlSurveyAgeDwt | 15 846 (15 279-16 420) | 11 042 (8 025-15 027) | 0.698 (0.51-0.932) | 0.998 | 1.000 | 1.000 |
| UnreportedCatchZero | 13 518 (13 141-13 900) | 8 863 (6 594-11 982) | 0.656 (0.491-0.879) | 1.000 | 1.000 | 1.000 |

| | $F_{SB40\%}$ | $F_{2020}/F_{SB40\%}$ | Pr($F_{2020} < F_{SB40\%}$) |
|---|---|---|---|
| **Base** | 0.052 | 0.524 (0.389-0.737) | 0.999 |
| LowM | 0.044 | 0.703 (0.521-0.952) | 0.986 |
| Mature5yr | 0.050 | 0.562 (0.414-0.78) | 1.000 |
| Model_CPUE | 0.051 | 0.660 (0.456-0.966) | 0.985 |
| Model_TrawlSurvey | 0.054 | 0.573 (0.406-0.816) | 0.997 |
| Model_BPTage | 0.052 | 0.474 (0.333-0.963) | 0.976 |
| SigmaR1.0 | 0.050 | 0.554 (0.407-0.761) | 1.000 |
| TrawlSurveyAgeDwt | 0.052 | 0.491 (0.355-0.696) | 1.000 |
| UnreportedCatchZero | 0.052 | 0.558 (0.406-0.761) | 1.000 |

**Table 13: Estimates of equilibrium yield (t) at $F_{SB40\%}$ at the 2020–21 biomass levels and at 40% $B_0$, for the base model and the model sensitivities. The values represent the median and the 95% confidence interval from the MCMCs.**

| Model option | $F_{SB40\%}$ | |
|---|---|---|
| | Yield at 40% $B_0$ | Yield at current biomass |
| **Base** | 696 (634-738) | 1 251 (859-1 694) |
| LowM | 616 (556-653) | 950 (716-1 252) |
| Mature5yr | 691 (630-729) | 1 159 (840-1 581) |
| Model_CPUE | 683 (608-736) | 1 034 (721-1 457) |
| Model_TrawlSurvey | 715 (651-743) | 1 120 (790-1 609) |
| Model_BPTage | 871 (758-1 000) | 1 416 (800-1 989) |
| SigmaR1.0 | 661 (592-702) | 1 224 (905-1 670) |
| TrawlSurveyAgeDwt | 684 (598-728) | 1 257 (881-1 766) |
| UnreportedCatchZero | 591 (536-625) | 1 093 (797-1 492) |

## Projections

Projections were conducted for the base model and the sensitivities. Stock projections were conducted for the 5-year period following the terminal year of the model (i.e., 2021–2025). Projections assumed future recruitments were resampled from the lognormal distribution around the geometric mean. Commercial catches in the projection period were held constant at the current TACC of 350 t with an allowance for additional mortality of 35 t. Recreational catches in the projection period assumed a constant level of fishing mortality equivalent to the fishing mortality estimated in the terminal year of the model (2020). 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). These year classes are poorly estimated as they have only been observed once (2018 year class) or twice (2017 year class) in the trawl survey series and have not yet appeared in the commercial fishery. There is concern that the strength of these year classes may be over-estimated in the assessment models resulting in overly optimistic stock projections. A more precautionary metric of projected stock status was derived from the lower 25% quantile of the distribution of projected stock biomass, reflecting the lower range of biomass from the lower range of the estimates of the recent recruitments.

For the base case (and all other model options), stock abundance is predicted to continue to increase in the projection period and biomass is well above the target biomass ($SB_{40\%}$ level) in 2025 (Table 14). Recreational catches are projected to increase in proportion to the overall increase in stock biomass. The median of the lower 25% quantile (0.731) of the projected biomass is also higher than the estimate of current stock status (0.628) indicating that biomass increases at the lower range of values estimated for the recent recruitments.

**Table 14: Estimates of projected (2025–26) spawning biomass (t) (median and the 95% confidence interval from the MCMCs) and probability of the spawning biomass being above default biomass limits and the interim target level in 2025 from the base model projections and the lower 25% quantile of the projections.**

| **Model option** | $SB_{2025}/SB_0$ | ***Pr(SB 2025 > X% SB₀)*** | | |
|---|---|---|---|---|
| | | **10%** | **20%** | **40%** |
| **Base** | 0.895 (0.631-1.279) | 1.00 | 1.00 | 1.00 |
| **Lower 25% Quantile** | 0.731 (0.561-0.797) | 1.00 | 1.00 | 1.00 |

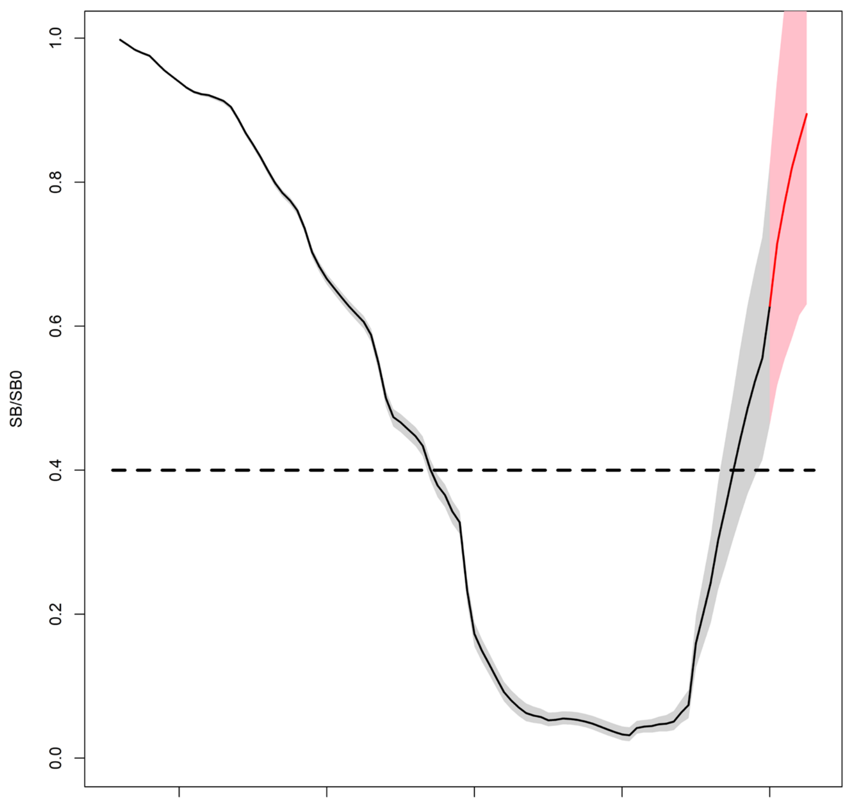



**Figure 6: Annual trend in spawning biomass relative to the 40% $SB_0$ interim target biomass level for the base model. The line represents the median and the shaded area represents the 95% confidence interval. The projection period (2021–2025) is in red. The dashed line represents the interim target level.**

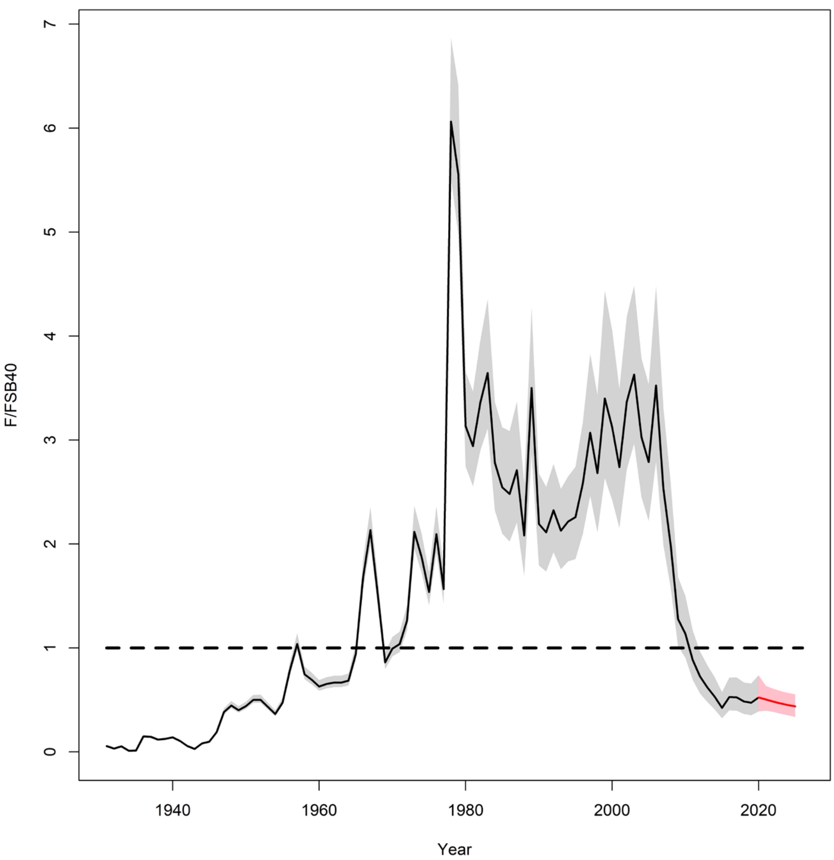



**Figure 7: Annual trend in fishing mortality relative to the $F_{SB40\%}$ interim target biomass level for the base model. The line represents the median and the shaded area represents the 95% credible interval. The projection period (2021–2025) is in red. The dashed line represents the interim target level.**

## 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%).

The level of stock depletion in the mid-1980s is strongly determined by the large catches taken during the late 1970s and early 1980s. There is an assumed level of unreported catch taken throughout the period based on assumed levels of under-reporting from the SNA 1 and SNA 8 fisheries (i.e., 20% of the reported catch). Several participants in the SNA 7 trawl fishery during that period were interviewed. The interviewees considered that unreported catches (including discards) of snapper were minor and that the assumed 20% overrun was unrealistically high. A model sensitivity revealed that stock status was not sensitive to the assumptions regarding unreported catch, although the level of assumed catch does influence the estimates of long-term yield.

During the earlier period of the fishery (prior to 1970) the trawl method may have had lower selectivity for larger (older) snapper than is currently estimated by the assessment model. Model trials have indicated that the estimates of current stock status are not sensitive to the assumptions regarding the selectivity of the trawl fishery in the early period.

For the previous assessment, 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 under-estimate 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 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 yr) snapper which are predominantly found within the shallower areas (<20m) 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. 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 yr) fish. However, the limited number of observations (3 surveys) meant 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 survey has reaffirmed the presence of a (very) strong 2017 year class and indicated that the 2018 year class is also likely to be strong. However, there is only a single observation of the 2018 year class from the trawl survey which is not sufficient to precisely quantify the magnitude of this year class.

**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 yr) snapper enabling recent recruitments to be estimated in the stock assessment model and should be continued on the current biennial basis.
- The potential to utilise the surveys to derive numbers at age indices for younger (1-4 yr) age classes should be explored.
- Explore alternative approaches to incorporating data from the new 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 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.
- Concurrent sampling of SNA 7 and SNA 8 (particularly the south Taranaki region) would enable an evaluation of the connectivity between the two QMAs.

Recreational harvest estimates
- The recreational catches from the period prior to 2005 have been assumed and are highly uncertain. Future modelling should include an evaluation of alternative levels of recreational catch from this period.
- 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.

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).

Dynamic $B_0$
- Recent recruitment is estimated to be at an historically high level suggesting the stock is currently in a phase of higher productivity and that there is a degree of non-stationarity in the assumed nature of the relationship between spawning biomass and recruitment that is likely to violate the assumptions of equilibrium conditions. Further consideration is required to develop stock status indicators that account for an increase in the productivity of the SNA 7 stock.

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.

Fisher behaviour impacts on CPUE
- 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.

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.

## 5. STATUS OF THE STOCKS

### Stock Structure Assumptions

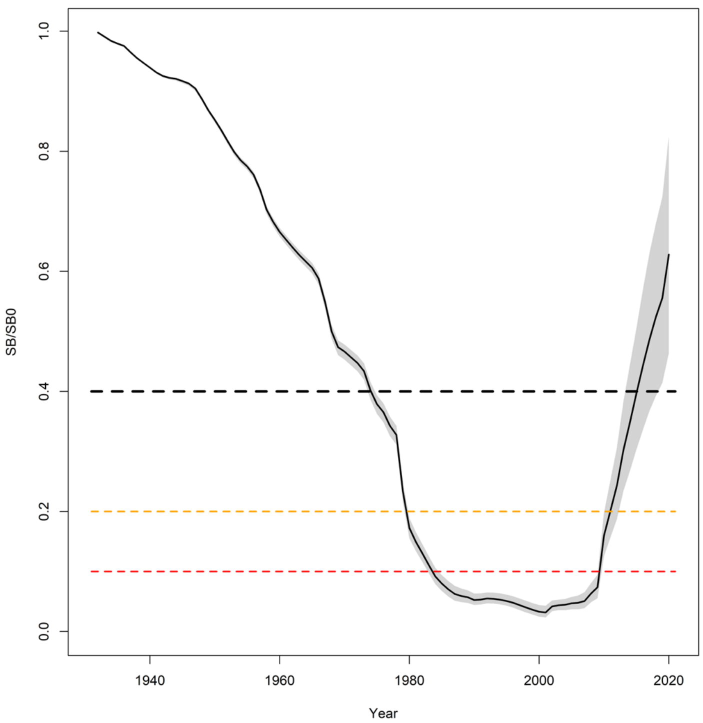
New Zealand snapper are thought to comprise either seven or eight biological stocks based on the location of spawning and nursery grounds, differences in growth rates, age structure, and recruitment strength, and the results of tagging studies. These stocks are assumed to comprise three in SNA 1 (East 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), 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 excluded as it is considered to support a separate stock of snapper within SNA 7.

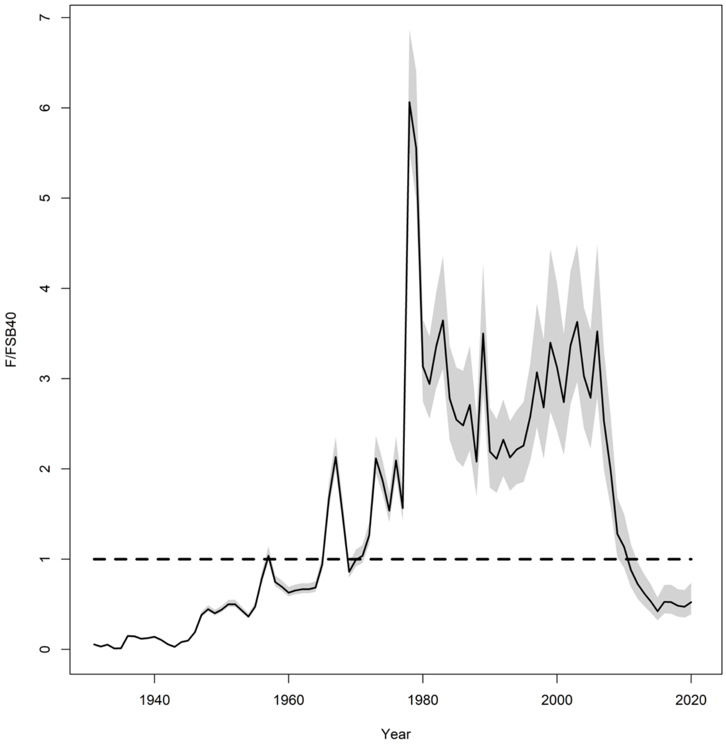
| **Stock Status** | |
|---|---|
| Year of Most Recent Assessment | 2022 |
| Assessment Runs Presented | Base case model |
| Reference Points | Interim target: 40% $SB_0$<br>Soft Limit: 20% $SB_0$<br>Hard Limit: 10% $SB_0$<br>Interim overfishing threshold: $F_{SB40\%}$ |
| Status in relation to Target | $B_{2020–21}$ was estimated to be 63% $B_0$; Very Likely (> 90%) to be at or above the target |
| Status in relation to Limits | Soft Limit: Exceptionally Unlikely (< 1%) to be below<br>Hard Limit: Exceptionally Unlikely (< 1%) to be below |
| Status in relation to Overfishing | $F$ was estimated to be 0.52 $F_{SB40\%}$; overfishing is Very Unlikely (< 10%) to be occurring |

**Historical Stock Status Trajectory and Current Status**

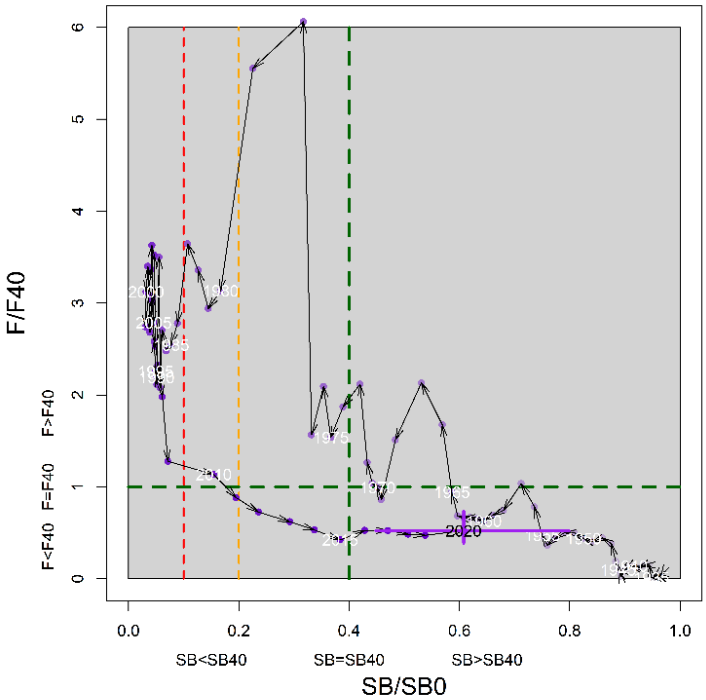



**Annual trend in spawning biomass relative to the 40% $SB_0$ interim target biomass level for the base model. The line represents the median and the shaded area represents the 95% credible interval. The black dashed line represents the interim target level. The red and orange dashed lines represent 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. More recent recruitments have also been well above average. |
| 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. |




**Annual trend in fishing mortality relative to the $F_{SB40\%}$ interim target biomass level for the base model. The line represents the median and the shaded area represents the 95% credible interval. The dashed line represents the interim target level.**




**Annual spawning biomass and fishing mortality compared to the $SB_{40\%}$ interim target biomass level and corresponding fishing mortality reference for the base model (median values from MCMCs and 95% confidence intervals for the terminal year). The green dashed lines represent the biomass and fishing mortality target levels. The red and orange dashed lines represent the hard and soft biomass limits, respectively.**

| | |
|---|---|
| Other Abundance Indices | - The BT1 CPUE index post 2010 although assumed to be biased low also shows a substantial increase. |
| Trends in Other Relevant Indicators or Variables | - The increase in recreational catch estimates from 2005 onwards suggests that abundance has increased. |

| **Projections and Prognosis** | |
|---|---|
| Stock Projections or Prognosis | Projections (5 yr) are provided based on long-term average recruitment, using both the median and 25th percentiles.<br>Biomass is projected to continue to increase at the level of the current TACC and increasing recreational catch. |
| Probability of Current Catch or TAC causing Biomass to remain below or to decline below Limits | Soft Limit: Exceptionally Unlikely (< 1%)<br>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: 2022 | Next assessment: 2024 |
| Overall assessment quality rank | 1 – High Quality | |
| Main data inputs (rank) | - Commercial catch history (1983 onwards) | 1 – High Quality |
| | - Commercial catch history (pre-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 or Mixed 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) | 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: biased low due to avoidance behaviour |
| Changes to Model Structure and Assumptions | - Inclusion of Kaharoa trawl survey biomass indices (Core area TBGB+WCSI) | |

| | |
|---|---|
| | - Seasonal stratification of fishery catches, CPUE indices, and age composition<br>- Parameterisation of trawl fishery selectivity (Jan-Apr)<br>- Parameterisation of trawl survey selectivity<br>- CPUE data (October to December) post 2010 excluded<br>- Recruitment estimated from 1975, previously from 1950 |
| Major Sources of Uncertainty | - Strength of recent recruitment (2017 and 2018 year classes)<br>- Historical commercial catches<br>- Historical and projected levels of recreational catch<br>- Availability of older (10+ yr) snapper to the trawl survey and summer commercial trawl fishery<br>- Connectivity between SNA 7 and southern SNA 8 |

| Qualifying Comments |
|---|
| It was recognised that if the increases in abundance represent a regime shift, or a significant change in productivity levels, with an associated increase in $B_0$, then the use of historical levels of relative abundance to establish target and limit reference points may not be appropriate. |

| 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. |

## 6. FOR FURTHER INFORMATION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