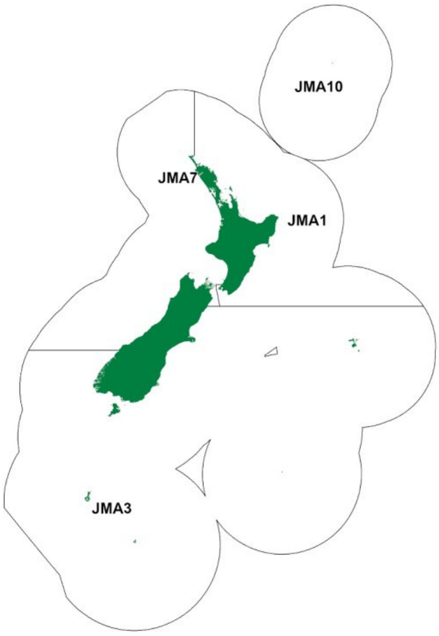
# JACK MACKERELS (JMA)

(*Trachurus declivis*, *Trachurus novaezelandiae*, *Trachurus murphyi*)
Hauture





## 1. FISHERY SUMMARY

The jack mackerel fisheries catch three species: two endemic species, *Trachurus declivis* and *T. novaezelandiae*, and *T. murphyi* which appeared in New Zealand in the 1980s.

Jack mackerels were introduced to the Quota Management System (QMS) on 01 October 1987. The process was impacted by the Muriwhenua Fishing Claim (Jones 1988, Waitangi Tribunal 1988). The Territorial Sea north of 36°S was originally excluded from the JMA 1 and JMA 7 Quota Management Areas (QMAs), but included in these QMAs from 1 October 1996. In JMA 1 and JMA 3 the issuing of Individual Transferable Quota was delayed and individual quotas were allocated annually in these areas from the 1988 to 1996 fishing years. Allowances for customary non-commercial fishers, recreational fishers, and an allowance for other sources of mortality have only been set in JMA 3 (Table 1).

**Table 1: TACs, TACCs, and allowances (t) for jack mackerels by fishstock.**

| Fishstock | TAC | TACC | Customary allowance | Recreational allowance | Other mortality |
|---|---|---|---|---|---|
| JMA 1 | – | 10 000 | – | – | – |
| JMA 3 | 9 000 | 8 780 | 20 | 20 | 180 |
| JMA 7 | – | 32 537 | – | – | – |
| JMA 10 | – | 10 | – | – | – |

### 1.1 Commercial fisheries

In JMA 1, the jack mackerel catch is largely taken by the target purse seine fishery operating in the Bay of Plenty in Statistical Area 009 during March–November, with minor catches taken as a bycatch of kahawai and blue mackerel purse seine fisheries, and as a bycatch from trawl fisheries. In most years, relatively small catches were taken from off the east Northland coast (Statistical Areas 002 and 003), although this area accounted for a substantial proportion of the total catch in 1993–94 and 1994–95.

Since 1991–92, jack mackerel targeted landings in JMA 1 have represented more than 80% of total catch. The highest rates of bycatch are from kahawai and blue mackerel targeted operations which each account for about 7% of the total jack mackerel catch.

In JMA 3 little targeting occurred before 1992–93. During the 1990s targeting increased and accounted for the majority of catch (about 50% between 1991–92 and 1996–97), but, after a peak of more than 80% in 1997–98 and 1998–99, the target catch has decreased again to about 50–60% in recent years. The balance of the catch in this area comes from trawl bycatch (squid 15–30%, barracouta 15–20%) on the Chatham Rise and in the Southland/Sub-Antarctic region. A purse seine fishery has operated between the Clarence River mouth and the Kaikōura Peninsula, which peaked at 4400 t in 1992–93 and averaged more than 3000 t between 1989–90 and 1993–94. Purse seine catches have shown a steady decline since, dropping from 1000 t in 1994–95, to 100 t in 2001–02 and 2002–03; no catch was recorded for 2003–04, and purse seine catch has subsequently been rare.

Increased availability of jack mackerels caused by the influx of *T. murphyi* resulted in increased TACCs in JMA 1 and JMA 3, to 8000 t and 9000 t, respectively, for the 1993–94 fishing year, and a further increase to 10 000 t and 18 000 t, respectively, for the 1994–95 year. The latter increases were made under the proviso that they be accounted for by increased catches of *T. murphyi* only; combined landings of *T. declivis* and *T. novaezelandiae* in JMA 1 and JMA 3 must not exceed the original quotas of 5970 t and 2700 t, respectively. Industry agreed to these limits and voluntarily introduced monitoring programmes to provide the information necessary for them to be met.

From the 2016–17 fishing year, the TACC for JMA 3 was reduced to 8780 t, approximating the 1993–94 TACC level, on the basis that recent catches had been considerably lower than the TACC and that catches of *T. murphyi* were minimal, indicating low abundance of the species in New Zealand waters in recent years.

The three species occur in each of the Fishstocks but are not individually identified in catch reporting. Historical estimated and recent reported jack mackerel landings and TACCs are shown in Tables 1 and 2, and Figure 1 shows the historical landings and TACC values for the main JMA stocks. Total annual landings have ranged between 21 059 t and 50 388 t since 1986–87 (Table 3).

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

| Year | JMA 1 | JMA 3 | JMA 7 | Year | JMA 1 | JMA 3 | JMA 7 |
|---|---|---|---|---|---|---|---|
| 1931–32 | 0 | 0 | 0 | 1957 | 0 | 0 | 6 |
| 1932–33 | 0 | 0 | 0 | 1958 | 0 | 0 | 9 |
| 1933–34 | 0 | 0 | 0 | 1959 | 2 | 0 | 0 |
| 1934–35 | 0 | 0 | 0 | 1960 | 2 | 0 | 5 |
| 1935–36 | 0 | 0 | 0 | 1961 | 1 | 0 | 5 |
| 1936–37 | 0 | 0 | 0 | 1962 | 5 | 0 | 5 |
| 1937–38 | 0 | 0 | 0 | 1963 | 7 | 2 | 13 |
| 1938–39 | 0 | 0 | 0 | 1964 | 5 | 4 | 10 |
| 1939–40 | 1 | 0 | 0 | 1965 | 14 | 0 | 8 |
| 1940–41 | 1 | 1 | 2 | 1966 | 47 | 0 | 54 |
| 1941–42 | 0 | 0 | 2 | 1967 | 213 | 0 | 250 |
| 1942–43 | 3 | 0 | 2 | 1968 | 172 | 505 | 4 558 |
| 1943–44 | 0 | 0 | 0 | 1969 | 128 | 388 | 7 065 |
| 1944 | 9 | 0 | 0 | 1970 | 75 | 1 029 | 7 274 |
| 1945 | 7 | 0 | 0 | 1971 | 473 | 776 | 12 684 |
| 1946 | 3 | 0 | 6 | 1972 | 350 | 5 450 | 15 581 |
| 1947 | 14 | 0 | 4 | 1973 | 395 | 1 238 | 14 648 |
| 1948 | 3 | 0 | 6 | 1974 | 1 236 | 2 016 | 16 943 |
| 1949 | 5 | 0 | 22 | 1975 | 204 | 3 615 | 10 043 |
| 1950 | 7 | 6 | 3 | 1976 | 838 | 5 690 | 14 228 |
| 1951 | 4 | 4 | 1 | 1977 | 1 317 | 5 228 | 13 729 |
| 1952 | 1 | 4 | 7 | 1978 | 1 250 | 1 547 | 4 657 |
| 1953 | 0 | 3 | 9 | 1979 | 2 158 | 516 | 4 475 |
| 1954 | 3 | 0 | 1 | 1980 | 2 504 | 104 | 3 533 |
| 1955 | 3 | 0 | 12 | 1981 | 2 815 | 110 | 8 665 |
| 1956 | 1 | 0 | 2 | 1982 | 1 607 | 119 | 8 364 |

Notes:
1. The 1931–1943 years are April–March but from 1944 onwards are calendar years.
2. Data up to 1985 are from fishing returns; data from 1986 to 1990 are from Quota Management Reports.
3. Data for the period 1931 to 1982 are based on reported landings by harbour and are likely to be underestimated as a result of under-reporting and discarding practices. Data include both foreign and domestic landings.

**Table 3: Reported landings (t) of jack mackerel by Fishstock from 1983–84 to present and actual TACCs (t) for 1986–87 to present. QMS data from 1986 to present. Quota Management Areas use the current definitions and catches from the Territorial Sea north of 36°S are included where these can be estimated from landings (CELR/CLR) data.**

| | JMA 1 | | JMA 3 | | JMA 7 | | JMA 10 | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Landings | TACC | Landings | TACC | Landings | TACC | Landings | TACC | Landings§ | TACC |
| 1983–84* | 3 682 | – | 715 | – | 12 464 | – | 0 | – | 16 861 | – |
| 1984–85* | 1 857 | – | 1 223 | – | 16 013 | – | 0 | – | 19 093 | – |
| 1985–86* | 1 173 | – | 2 228 | – | 10 002 | – | 0 | – | 13 403 | – |
| 1986–87 | 4 056 | 5 970 | 1 638 | 2 700 | 19 815 | 20 000 | 0 | 10 | 25 509 | 28 680 |
| 1987–88 | 3 108 | 5 970 | 1 883 | 2 700 | 17 879 | 22 697 | 0 | 10 | 22 870 | 31 377 |
| 1988–89 | 2 986 | 5 970 | 1 919 | 2 700 | 17 403 | 26 008 | 0 | 10 | 22 308 | 34 688 |
| 1989–90 | 4 226 | 5 970 | 4 013 | 2 700 | 21 776 | 32 027 | 0 | 10 | 30 015 | 40 707 |
| 1990–91‡ | 7 311 | 5 970 | 6 403 | 2 700 | 17 786 | 32 069 | 0 | 10 | 30 661 | 40 749 |
| 1991–92‡ | 7 812 | 5 970 | 5 779 | 2 700 | 25 880 | 32 069 | 0 | 10 | 38 676 | 40 749 |
| 1992–93‡ | 8 551 | 5 970 | 15 399 | 2 700 | 24 659 | 32 537 | 0 | 10 | 47 587 | 41 216 |
| 1993–94‡ | 14 258 | 8 000 | 9 115 | 9 000 | 22 377 | 32 537 | 0 | 10 | 45 748 | 49 546 |
| 1994–95‡ | 10 348 | 10 000 | 11 519 | 18 000 | 18 912 | 32 537 | 0 | 10 | 38 263 | 60 547 |
| 1995–96 | 6 874 | 10 000 | 19 803 | 18 000 | 12 270 | 32 537 | 0 | 10 | 38 947 | 60 547 |
| 1996–97 | 6 912 | 10 000 | 15 687 | 18 000 | 12 056 | 32 537 | 0 | 10 | 34 655 | 60 547 |
| 1997–98 | 7 695 | 10 000 | 15 452 | 18 000 | 14 293 | 32 537 | 0 | 10 | 37 440 | 60 547 |
| 1998–99 | 5 641 | 10 000 | 15 111 | 18 000 | 13 629 | 32 537 | 0 | 10 | 34 381 | 60 547 |
| 1999–00 | 2 864 | 10 000 | 10 306 | 18 000 | 7 889 | 32 537 | 0 | 10 | 21 059 | 60 547 |
| 2000–01 | 8 360 | 10 000 | 2 744 | 18 000 | 15 703 | 32 537 | 0 | 10 | 26 807 | 60 547 |
| 2001–02 | 5 247 | 10 000 | 5 000 | 18 000 | 22 338 | 32 537 | 0 | 10 | 32 585 | 60 547 |
| 2002–03 | 6 172 | 10 000 | 2 225 | 18 000 | 26 084 | 32 537 | 0 | 10 | 34 481 | 60 547 |
| 2003–04 | 7 396 | 10 000 | 705 | 18 000 | 28 888 | 32 537 | 0 | 10 | 36 989 | 60 547 |
| 2004–05 | 9 418 | 10 000 | 716 | 18 000 | 36 507 | 32 537 | 0 | 10 | 46 641 | 60 547 |
| 2005–06 | 9 924 | 10 000 | 5 000 | 18 000 | 27 782 | 32 537 | 0 | 10 | 42 706 | 60 547 |
| 2006–07 | 5 293 | 10 000 | 1 857 | 18 000 | 32 039 | 32 537 | 0 | 10 | 39 189 | 60 547 |
| 2007–08 | 11 167 | 10 000 | 2 629 | 18 000 | 34 059 | 32 537 | 0 | 10 | 47 855 | 60 547 |
| 2008–09 | 9 791 | 10 000 | 1 964 | 18 000 | 28 828 | 32 537 | 0 | 10 | 40 583 | 60 547 |
| 2009–10 | 9 086 | 10 000 | 2 706 | 18 000 | 31 152 | 32 537 | 0 | 10 | 42 944 | 60 547 |
| 2010–11 | 8 262 | 10 000 | 3 592 | 18 000 | 28 177 | 32 537 | 0 | 10 | 40 031 | 60 547 |
| 2011–12 | 8 911 | 10 000 | 3 085 | 18 000 | 28 266 | 32 537 | 0 | 10 | 40 261 | 60 547 |
| 2012–13 | 8 054 | 10 000 | 3 830 | 18 000 | 31 776 | 32 537 | 0 | 10 | 43 659 | 60 547 |
| 2013–14 | 10 520 | 10 000 | 4 693 | 18 000 | 35 175 | 32 537 | 0 | 10 | 50 388 | 60 547 |
| 2014–15 | 10 177 | 10 000 | 4 115 | 18 000 | 33 970 | 32 537 | 0 | 10 | 48 262 | 60 547 |
| 2015–16 | 6 989 | 10 000 | 2 756 | 18 000 | 30 875 | 32 537 | 0 | 10 | 40 621 | 60 547 |
| 2016–17 | 8 890 | 10 000 | 4 665 | 8 780 | 33 802 | 32 537 | 0 | 10 | 47 357 | 51 327 |
| 2017–18 | 5 553 | 10 000 | 5 559 | 8 780 | 34 190 | 32 537 | 0 | 10 | 45 302 | 51 327 |
| 2018–19 | 4 332 | 10 000 | 4 651 | 8 780 | 31 752 | 32 537 | 0 | 10 | 40 735 | 51 327 |
| 2019–20 | 6 478 | 10 000 | 5 355 | 8 780 | 31 451 | 32 537 | 0 | 10 | 43 284 | 51 327 |
| 2020–21 | 6 777 | 10 000 | 5 601 | 8 780 | 31 810 | 32 537 | 0 | 10 | 44 188 | 51 327 |
| 2021–22 | 3 455 | 10 000 | 4 858 | 8 780 | 27 782 | 32 537 | 0 | 10 | 36 095 | 51 327 |
| 2022–23 | 3 328 | 10 000 | 5 300 | 8 780 | 34 549 | 32 538 | 0 | 10 | 43 178 | 51 327 |

* FSU data.
§ Includes landings from unknown areas before 1986–87.
‡ JMA 1 landings are totals from CLR and CELR data.

Landings in JMA 1 before 1989–90 were generally well below the quota of 5970 t (Table 3), with the maximum in 1986–87 only slightly above 4000 t. Landings increased to 7529 t in 1992–93, followed by a substantial increase to the highest recorded value of 14 256 t in 1993–94, which was more than twice the original quota and exceeded the quota of 8000 t set for that yearOver the period 1997–98 to 2004–05, annual catches from JMA 1 increased to near the level of the TACC (10 000 t) and, until 2014–15, annual catches fluctuated about 8000–10 000 t, with the exception of a considerably lower catch in 2006–07 and a peak catch of 11 200 t in 2007–08. JMA 1 landings since 2015–16 have been consistently less than the TACC of 10 000 t. The 2018–19 JMA 1 landings were the lowest since 1999–00 (at 4332 t), then increased to 6777 t in 2020–21, but decreased to 3328 t in 2022–23.

Estimates of the species composition of the JMA 1 purse seine catches are available from 1989–90 to 2022–23 (Figure 2, Table 4). During 1989–90 and 1990–91, annual catches were dominated by *T. novaezelandiae*, but included a small component of *T. declivis*. The proportion of *T. murphyi* in the catch increased considerably over the following years, accounting for 65% of the total catch in 1993–94 and continued to account for a considerable proportion of the JMA 1 catch during 1994–95 to 1998–99. Since 1999–00, annual catches of *T. murphyi* have generally been small, although they comprised 11% of the catch in 2003–04 and 26% in 2006–07. From 1999–00 to 2022–23, annual catches from JMA 1 were generally dominated by *T. novaezelandiae.* The annual catch of this species ranged from about 2000 t to 5000 t during the 1990s, and averaged 8135 t in 2007–08 to 2016–17. Correspondingly, cumulative catches of *T. declivis* and *T. murphyi* were low during this period (7% and 2%, respectively). Catches from the purse seine fishery in 2017–18 to 2022–23 were lower overall, following a reduction in fleet size and change from using brine to refrigerated sea water as the onboard storage medium. The mean annual catch of *T. novaezelandiae* in this period was 3229 t, while the mean annual catch of *T. declivis* was 1368 t, and exceeded 2000 t in 2017–18 and 2019–20.

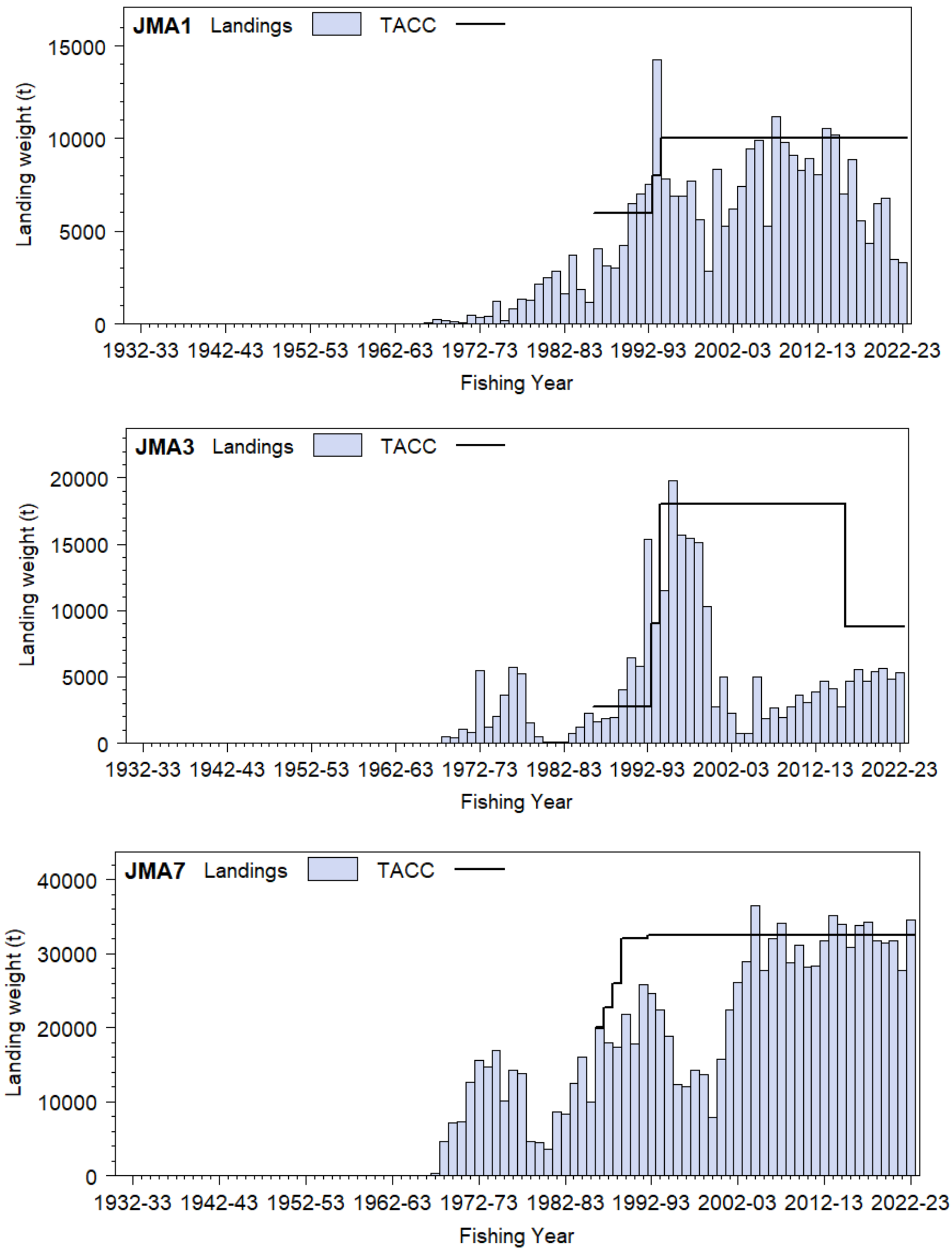



**Figure 1: Reported commercial landings and TACC for the three main JMA stocks. From top: JMA 1 (Auckland East, Central East), JMA 3 (South East coast, South East Chatham Rise, Sub-Antarctic, Southland), and JMA 7 (Challenger, Central Egmont, Auckland West).**

Total landings in JMA 3 over the period 1984–85 to 1988–89 were relatively constant, at a level below the quota of 2700 t. Landings increased over subsequent years to peak in 1992–93 at almost three times that of the preceding year and more than five times the quota. Under the first of two consecutive annual increases to the JMA 3 TACC in 1993–94, landings were slightly above the limit set, but dropped well below the higher TACC level in 1994–95. The lower 1994–95 catch relative to that in 1992–93 has been attributed to the delayed implementation of the quota, less targeting of jack mackerel, and low bycatch in the squid trawl fishery. Landings in JMA 3 increased markedly in 1995–96 (19 803 t) to a value exceeding the quota, with catches remaining stable around 15 500 t over three subsequent years. More recently, landings have decreased to levels well below the TACC. Declines in landings are attributed to declining abundance of *T. murphyi*, which historically comprised the bulk of JMA 3 landings. JMA 3 landings have been stable in recent years (average 5115 t for 2016–17 to 2021–22).

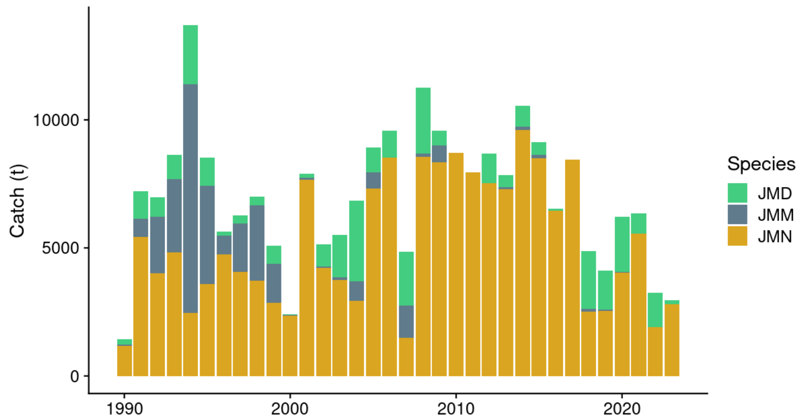



**Figure 2: The time series of annual species catch estimates from the JMA 1 purse seine fishery in East Northland and the Bay of Plenty (JMN, *T. novaezelandiae*; JMD, *T. declivis*; JMM, *T. murphyi*).**

**Table 4: JMA 1 purse seine catches from East Northland and the Bay of Plenty and the time series of annual estimates of the species composition of the catch (JMN, *T. novaezelandiae*; JMD, *T. declivis*; JMM, *T. murphyi*) (compiled from various sources, see appendix 5 of Langley et al 2016 and Middleton in prep).**

| Fishing year | Catch (t) | Species proportion JMD | JMM | JMN |
|---|---|---|---|---|
| 1989–90 | 1 433 | 0.15 | 0.04 | 0.81 |
| 1990–91 | 7 147 | 0.15 | 0.10 | 0.76 |
| 1991–92 | 6 921 | 0.11 | 0.32 | 0.58 |
| 1992–93 | 8 629 | 0.11 | 0.33 | 0.56 |
| 1993–94 | 13 710 | 0.17 | 0.65 | 0.18 |
| 1994–95 | 8 530 | 0.13 | 0.45 | 0.42 |
| 1995–96 | 5 643 | 0.03 | 0.13 | 0.84 |
| 1996–97 | 6 256 | 0.05 | 0.30 | 0.65 |
| 1997–98 | 7 009 | 0.05 | 0.42 | 0.53 |
| 1998–99 | 5 077 | 0.14 | 0.30 | 0.56 |
| 1999–00 | 2 416 | 0.01 | 0.01 | 0.98 |
| 2000–01 | 7 896 | 0.02 | 0.01 | 0.97 |
| 2001–02 | 5 146 | 0.17 | 0.01 | 0.82 |
| 2002–03 | 5 518 | 0.30 | 0.02 | 0.68 |
| 2003–04 | 6 838 | 0.46 | 0.11 | 0.43 |
| 2004–05 | 8 919 | 0.11 | 0.07 | 0.82 |
| 2005–06 | 9 568 | 0.11 | 0.00 | 0.89 |
| 2006–07 | 4 803 | 0.44 | 0.26 | 0.31 |
| 2007–08 | 11 270 | 0.23 | 0.01 | 0.76 |
| 2008–09 | 9 579 | 0.06 | 0.07 | 0.87 |
| 2009–10 | 8 714 | 0.00 | 0.00 | 1.00 |
| 2010–11 | 7 936 | 0.00 | 0.00 | 1.00 |
| 2011–12 | 8 765 | 0.13 | 0.00 | 0.86 |
| 2012–13 | 7 841 | 0.06 | 0.01 | 0.93 |
| 2013–14 | 10 543 | 0.08 | 0.01 | 0.91 |
| 2014–15 | 9 124 | 0.05 | 0.02 | 0.93 |
| 2015–16 | 6 521 | 0.01 | 0.00 | 0.99 |
| 2016–17 | 8 439 | 0.00 | 0.00 | 1.00 |
| 2017–18 | 4 884 | 0.46 | 0.02 | 0.51 |
| 2018–19 | 4 111 | 0.37 | 0.01 | 0.62 |
| 2019–20 | 6 208 | 0.35 | 0.00 | 0.65 |
| 2020–21 | 6 342 | 0.12 | 0.00 | 0.88 |
| 2021–22 | 3 245 | 0.41 | 0.00 | 0.59 |
| 2022–23 | 2 961 | 0.05 | 0.00 | 0.95 |

The largest jack mackerel fishery is in JMA 7. In the early 1990s, JMA 7 landings were mainly taken by bottom trawlers but, following a fleet transition in the mid-1990s to early 2000s, are now mainly taken by midwater trawlers. Landings fluctuated between 17 403 t and 25 880 t from 1986–87 to 1994–95. From 1995–96 to 1998–99, landings were in the range of 12 056–14 293 t. Subsequently, landings increased steadily from 15 703 t in 2000–01, peaking at 36 507 t in 2004–05 (exceeding the TACC by 3971 t). From 2005–06 to 2022–23, catches have fluctuated around the TACC.

A number of factors have been identified that can influence landing volumes in the jack mackerel fisheries. In the purse seine fishery during the 1990s, jack mackerel was often mixed with kahawai. Fishing companies tend to avoid these mixed schools to conserve kahawai quota, particularly at the beginning of the fishing year. When mixing of the two species is prevalent, a low kahawai TACC can result in the targeting of jack mackerel being inhibited. Both skipjack tuna and blue mackerel have been fished in preference to jack mackerel in the purse seine fishery, with the jack mackerel season being influenced by the availability of these species. However, global increases in the market price for jack mackerel have increased its importance in the purse seine fishery to a level similar to that for blue mackerel, and, as a result, the seasonal catch for jack mackerel has broadened considerably in recent years. This has provided fishers with a cost-effective alternative to traditional purse seine targets, particularly skipjack tuna, which incurs higher costs related to onboard storage and handling.

In recent years, there has been a change in the operation of the JMA 1 purse-seine fleet. In response to market requirements, fish are no longer stored in brine on board the vessel. This has resulted in shorter trip durations and consequently a concentration of fishing effort in the Bay of Plenty (where *T. novaezelandiae* dominate) near the processing facilities in Tauranga. Market requirements for fish size also affect the jack mackerel species targeted, and consequently the areas fished.

In the trawl fisheries (JMA 3 and 7) the majority of Japanese vessels (and hence the destination market) exited the fishery in the mid to late 1990s. The influx of *T. murphyi* also altered the value mix because the New Zealand species had a higher market value (at least in Japan). Since 2000, the target trawl fishery has been dominated by BATM vessels (specifically Pulkovskiy Meridian/BATM-1288 vessels, a class of 104 m factory trawlers constructed in eastern Europe and designed for distant-water fisheries) which have high processing capacity focussed on whole (GRE) or Headed and Gutted (H&G) product. These vessels operate across a range of bulk fisheries, often seasonal (e.g., SQU SBW, HOK), which means the apparent seasonality of JMA effort is primarily driven by the need to operate in the biologically seasonal (e.g., spawn) fisheries of various species as required, with JMA targeted in the temporal gaps between these events through the year.

Vessels over 46 m (i.e., all vessels in the JMA 7 midwater fleet) are excluded from nearshore areas throughout the JMA 7 QMA. These areas may represent a significant part of the habitat of jack mackerels. Vessels in this fishery have also worked to minimise bycatch of kingfish, snapper, and also common dolphins. Nevertheless, these restrictions do not appear to have constrained the fishery from taking the TACC in most years.

### 1.2 Recreational fisheries

Jack mackerels do not rate highly as a recreational target species although they are popular as bait.

Recreational catch in the northern region (JMA 1) was estimated at 333 000 fish (CV 0.13) by a diary survey in 1993–94 (Bradford 1996), 79 000 fish (CV 0.16) in a national recreational survey in 1996 (Bradford 1998), 349 000 fish (CV 39%) in the 2000 survey (Boyd & Reilly 2004) and 295 000 fish (CV 0.2%) in the 2001 survey (Boyd et al 2004). The surveys suggest a harvest of 80–110 t per year for JMA 1, insignificant in the context of the commercial catch. Estimates from other areas are very low (between 500 and 47 000 fish) and are insignificant in the context of the commercial catch

The harvest estimates provided by telephone/diary surveys between 1993 and 2001 are no longer considered reliable for various reasons. A Recreational Technical Working Group concluded that these harvest estimates should be used only with the following qualifications: a) they may be very inaccurate; b) the 1996 and earlier surveys contain a methodological error; and c) the 2000 and 2001 estimates are implausibly high for many important fisheries. In response to these problems and the cost and scale challenges associated with onsite methods, a national panel survey was conducted for the first time throughout 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 harvest information collected in 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 5. Note that national panel survey estimates do not include recreational harvest taken under s111 general approvals.

**Table 5: Recreational harvest estimates for jack mackerel stocks (Wynne-Jones et al 2014, 2019). Mean fish weights were obtained from boat ramp surveys (Hartill & Davey 2015, Davey et al 2019).**

| Stock | Year | Method | Number of fish | Total weight (t) | CV |
|---|---|---|---|---|---|
| JMA 1 | 2011–12 | Panel survey | 101 076 | 32.2 | 0.21 |
| | 2017–18 | Panel survey | 62 710 | 18.6 | 0.24 |
| | 2022–23 | Panel survey | 53 438 | 22.1 | 0.27 |
| JMA 3 | 2011–12 | Panel survey | 50 | <1 | 1.01 |
| | 2017–18 | Panel survey | 0 | 0 | – |
| | 2022–23 | Panel survey | 0 | 0 | – |
| JMA 7 | 2011–12 | Panel survey | 19 991 | 10.2 | 0.58 |
| | 2017–18 | Panel survey | 20 026 | 6.2 | 0.51 |
| | 2022–23 | Panel survey | 5 503 | 2.6 | 0.44 |

### 1.3 Customary non-commercial fisheries
Quantitative information on the current level of Māori customary non-commercial catch is not available.

### 1.4 Illegal catch
There is no information on illegal activity or catch but it is considered to be insignificant.

### 1.5 Other sources of mortality
There is no information on other sources of mortality.

## 2. BIOLOGY

The three species of jack mackerel in New Zealand have different geographical distributions, but their ranges partially overlap. *T. novaezelandiae* predominates in waters shallower than 150 m and warmer than 13 ºC; it is uncommon south of latitude 42º S. *Trachurus declivis* generally occurs in deeper (but less than 300 m) waters cooler than 16 ºC, north of latitude 45º S (Robertson 1978). *Trachurus murphyi* occurs to depths of least 500 m and has a wide latitudinal range (0º at the Galapagos Islands and coastal Ecuador, to south of 40º S off the Chilean coast) (Kawahara et al 1988).

*Trachurus murphyi* was first described from New Zealand waters in 1987 (Kawahara et al 1988). Its presence was recorded off the south and east coasts of the South Island. Its distribution expanded to off the west coast of the South Island and the North and South Taranaki bights by the late 1980s, reaching the Bay of Plenty in appreciable quantities by 1992, and becoming common off the east coast of Northland by June 1994. However, this extensive distribution has decreased in more recent years and, since the late 1990s, its presence north of Cook Strait has been sporadic with occasional landings in the JMA 1 purse seine fishery north of East Cape and from the JMA 1 inshore trawl fishery south of East Cape. The total range of *T. murphyi* extends along the west coast of South America, across the South Pacific, to the New Zealand EEZ, and into waters off south-eastern Australia.
All species can be caught by bottom trawl, midwater trawl, or by purse seine nets targeting surface schools. The vertical and horizontal movement patterns are poorly understood. Jack mackerels are presumed to be generally off the bottom at night, and surface schools can be quite common during the day.

Jack mackerels have a protracted spring-summer spawning season. *T. novaezelandiae* probably matures at about 26–30 cm fork length (FL) at an age of 3–4 years, and *T. declivis* matures when about 26–

30 cm FL at an age of 2–4 years. Spawning occurs in the North and South Taranaki bights, and probably in other areas as well.

The reproductive biology of *T. murphyi* in New Zealand waters is not well understood. Pre- and post-spawning fish have been recorded from the Chatham Rise, Stewart-Snares shelf, Northland east coast, and off Kaikoura in summer, but it is unknown whether there has been any resulting recruitment in New Zealand waters. A study by Taylor (2002a) showed that older size/age groups become increasingly dominant in catches westward from the South American coast, suggesting that an eastward migration of oceanic spawned larvae and juveniles occurs in the South Pacific Ocean.

Horn (1993) fitted von Bertalanffy growth curves for *T. novaezelandiae* and *T. declivis* to samples collected from the central west coast and in the Bay of Plenty between 1974 and 1991. No significant sexual differences in growth were apparent for either species but geographical differences were indicated for *T. novaezelandiae*. Hartill et al (2022) have provided updated estimates of growth parameters for *T. novaezelandiae* in JMA 1. Updated estimates for *T. novaezelandiae* and *T. declivis* in have been provided by Neubauer & Middleton (in prep) using a mixture modelling approach that simultaneously estimated growth parameters and the correct species for otoliths collected by observers in the JMA 7 fishery (see Section 5.1 below). *Trachurus novaezelandiae* and *T. declivis* have moderate initial growth rates that slow after about 6 years. Both species reach a maximum age of 25+ years.

*Trachurus murphyi* has proven difficult to age with markedly varying growth parameters estimated from fish sampled off South America (Horn & Ó Maolagáin 2021). Using otolith samples from JMA 7 in the period 2006–07 to 2018–19, Horn & Ó Maolagáin (2021) estimate that the mean asymptotic length of male *T. murphyi* in New Zealand is larger than that of females. Initial growth is rapid, slowing at 6–7 years, and *T. murphyi* is a moderately long-lived species with a maximum observed age of 38 years.

The best available estimate of $M$ for *T. novaezelandiae* and *T. declivis* is 0.18 based on the age-frequency distributions of lightly exploited populations in the Bay of Plenty. Assuming $M = 0.18$, estimates of $Z$ made in 1989 suggest that $F$ is less than 0.05 for both endemic species off the central west coast (the main jack mackerel fishing ground). Biological parameters relevant to the stock assessment are shown in Table 6.

**Table 6: Estimates of biological parameters.**

| Fishstock | | | Estimate | Source |
|---|---|---|---|---|
| 1. Natural mortality ($M$) | | | | |
| All | | | 0.18 | |
| | Considered best estimate for both endemic species from all areas. | | | Horn (1991a) |
| 2. Weight = $a$(length)$^b$ (Weight in g, length in cm fork length) | | | | |
| | | | All | |
| | | $a$ | $b$ | |
| *T. declivis* | | 0.023 | 2.84 | Horn (1991a) |
| *T. novaezelandiae* | | 0.0093 | 3.10 | Hartill et al (2022) |
| *T. murphyi* | | 0.016 | 2.85 | Basten (1981) |
| 3. von Bertalanffy growth parameters | | | | |
| | | | All | |
| | $L_\infty$ | $k$ | $t_0$ | |
| *T. declivis* (JMA 7) | 46 cm | 0.29 | -1.06 | Neubauer & Middleton (in prep) |
| *T. novaezelandiae* (JMA 1) | 34.5 cm | 0.34 | 0.1 | Hartill et al (2022) |
| *T. novaezelandiae* (JMA 7) | 34.5 cm | 0.30 | -0.72 | Neubauer & Middleton (in prep) |
| *T. murphyi* (JMA 7, females) | 50.7 cm | 0.231 | -0.5 (fixed) | Horn & Ó Maolagáin (2021) |
| *T. murphyi* (JMA 7, males) | 52.9 cm | 0.216 | -0.5 (fixed) | Horn & Ó Maolagáin (2021) |

## 3. STOCKS AND AREAS

There has been no work to investigate the stock boundaries for the native jack mackerels since their introduction to the QMS. For assessment purposes the three jack mackerel species are treated separately where possible.

Differences in growth rate of *T. novaezelandiae* and *T. declivis* between JMA 1 and JMA 7 may indicate stock separation.

There are two possible hypotheses on the stock structure of *T. murphyi* in New Zealand waters: it is either a separate stock established by fish migrating from South America, or part of a single, extensive trans-Pacific stock. Although successful recruitment in New Zealand waters would indicate the establishment of a separate stock, current evidence favours the latter hypothesis with an extensive stock between latitudes 35° and 50° S linking the coasts of Chile and New Zealand across what has been described as 'the jack mackerel belt'. Few detailed data are available to document the process of range expansion by *T. murphyi* or indicate the relative abundance of the three species in particular areas. As a requirement of the increased TACCs introduced in 1994–95, improvements to jack mackerel catch monitoring were made to provide adequate data for quantifying species composition and relative abundance in JMA 1 and JMA 3.

## 4. ENVIRONMENTAL AND ECOSYSTEM CONSIDERATIONS

This section was updated for the 2022 Fisheries Assessment Plenary based on Fisheries New Zealand data updates for jack mackerel fisheries interaction tables in this section. Fishery interactions are described more fully issue-by-issue 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

A study of fish assemblages using research trawls suggested that *Trachurus novaezelandiae* is part of an inshore assemblage that prefers shallow northern waters (centred on about 60 m depth and latitude about 38.7° S). All three species overlap spatially, but *T. declivis* is part of a deeper assemblage around central New Zealand (centred on about 130 m and about 40.1° S), and *T. murphyi* occurs deeper still and further south (centred on about 220 m and about 44.7° S) (Francis et al 2002). *T. novaezelandiae* and *T. declivis* range through the water column from surface to the sea floor. The behaviour of *T. murphyi* in New Zealand is less well known but studies off Chile suggest that this species tends to aggregate at night and that this could reflect nocturnal foraging (Bertrand et al 2004, 2006). The effect on the ecosystem of extracting, for example, between 5000 and 10 000 t of jack mackerels from JMA 1 and about 30 000 t from JMA 3 per year over the past decade is unknown.

#### 4.1.1 Trophic interactions

Stevens et al (2011) reported the diet of *T. novaezelandiae* and *T. declivis* from the Bay of Plenty, Northland, and off the west coast South Island to be predominantly euphausiids with fewer amphipods and fish (see also Hurst 1980). Crustaceans (several groups) were the dominant prey of *T. novaezelandiae* in the Hauraki Gulf, with fewer fish and polychaetes (Godfriaux 1968, 1970). The diet of *T. murphyi* from research trawls on shelf areas around New Zealand, mainly down to 500 m depth, included: crustaceans (55%, mainly euphausiids 38%, amphipods 12%, and *Munida* 6%); salps (36%); and teleosts (11% frequency of occurrence in non-empty stomachs, Stevens et al 2011).

Predators of jack mackerels are likely to include many fishes, seabirds, and marine mammals given the relatively high abundance of jack mackerels. The diet of gemfish from research trawls in Southland included *Trachurus* spp. (6% of total, Stevens et al 2011). *T. declivis* and *T. murphyi* were identified from the stomachs of leafscale gulper shark and Plunket's shark and *T. declivis* from the stomachs of school shark (Dunn et al 2010). The diet of spiny dogfish included scavenged jack mackerel (Dunn et al 2013).

### 4.2 Bycatch (fish and invertebrates)

Between 2009 and 2011, *T. novaezelandiae* dominated 97% of purse seine landings in JMA 1 (Walsh et al 2012). The estimated proportions by year were 1–17% for *T. declivis*, 0–3% for *T. murphyi*, and 81–99% for *T. novaezelandiae*. There was spatial and temporal heterogeneity in size and abundance; *T. novaezelandiae* dominated landings from the Bay of Plenty throughout the year and large *T. declivis* and *T. murphyi* were common in east Northland during winter (Walsh et al 2016).

Finucci et al (2020) used data from scientific observers and commercial catch-effort returns to estimate the rates and annual levels of fish and invertebrate bycatch and discards in the jack mackerel trawl fisheries, from 2002–03 to 2018–19. Jack mackerel species (*Trachurus* spp.) accounted for 78% of the total estimated catch from trawls targeting jack mackerels between 1 October 2002 and 30 September 2019. The remaining 22% comprised mostly other commercial species, including barracouta (*Thyrsites atun*, 11%), blue mackerel (*Scomber australasicus*, 3.1%), and frostfish (*Lepidopus caudatus*, 3.0%) (Table 7). Over 90% of reported catch was of QMS species, although altogether 370 taxa were identified by observers. Species with notable levels of discards included spiny dogfish (68%), kingfish (50%), porcupine fish (83%), and sunfish (100%).

**Table 7: Bycatch and discards from all observer records for the target trawl fishery for jack mackerel from 1 October 2002 to 30 September 2019 for species or species groups with a total catch of 100 kg or more, ordered by decreasing percentage of catch (Finucci et al in 2020).**

| Species code | Common name | Scientific name | Estimated catch (kg) | % of catch | % discarded |
|---|---|---|---|---|---|
| JMA/JMD/JMM/JMN | Jack mackerel | *Trachurus declivis, T. murphyi, T. novaezelandiae* | 279 209.8 | 77.7 | 0.0 |
| BAR | Barracouta | *Thyrsites atun* | 40 004.0 | 11.1 | 0.1 |
| EMA | Blue mackerel | *Scomber australasicus* | 11 140.8 | 3.1 | 0.0 |
| FRO | Frostfish | *Lepidopus caudatus* | 10 776.2 | 3.0 | 0.3 |
| RBT | Redbait | *Emmelichthys nitidus* | 8451.9 | 2.4 | 0.5 |
| STU | Slender tuna | *Allothunnus fallai* | 1057.6 | 0.3 | 3.1 |
| SPD | Spiny dogfish | *Squalus acanthias* | 845.6 | 0.2 | 68.1 |
| SWA | Silver warehou | *Seriolella punctata* | 786.5 | 0.2 | 0.0 |
| PIL | Pilchard | *Sardinops sagax* | 747.7 | 0.2 | 3.6 |
| RBM | Ray's bream | *Brama brama* | 698.2 | 0.2 | 0.0 |
| KIN | Kingfish | *Seriola lalandi* | 682.4 | 0.2 | 50.2 |
| WAR | Blue warehou | *Seriolella brama* | 525.5 | 0.1 | 0.0 |
| SNA | Snapper | *Chrysophrys auratus* | 485.4 | 0.1 | 0.3 |
| SDO | Silver dory | *Cyttus novaezealandiae* | 285.2 | 0.1 | 1.2 |
| TRE | Trevally | *Pseudocaranx georgianus* | 246.6 | 0.1 | 0.0 |
| JDO | John dory | *Zeus faber* | 225.9 | 0.1 | 0.0 |
| POP | Porcupine fish | *Allomycterus jaculiferus* | 219.0 | 0.1 | 82.7 |
| HOK | Hoki | *Macruronus novaezelandiae* | 193.3 | 0.1 | 0.1 |
| GUR | Gurnard | *Chelidonichthys kumu* | 178.0 | <0.1 | 0.1 |
| ATT | Kahawai | *Arripis trutta, A. xylabion* | 160.2 | <0.1 | 0.0 |
| MAK | Mako shark | *Isurus oxyrinchus* | 145.4 | <0.1 | 34.4 |
| NMP | Tarakihi | *Nemadactylus macropterus & N. rex* | 144.9 | <0.1 | 0.2 |
| SUN | Sunfish | *Mola mola* | 136.5 | <0.1 | 100.0 |
| THR | Thresher shark | *Alopias vulpinus* | 129.2 | <0.1 | 100.0 |

### 4.3 Incidental capture of protected species (mammals, seabirds, 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 that are struck by a warp but not brought onboard the vessel (Middleton & Abraham 2007).

#### 4.3.1 Marine mammal captures

Jack mackerel trawlers occasionally catch marine mammals, primarily common dolphin, long-finned pilot whale, and New Zealand fur seal (which are all classified as 'Not Threatened' under the New Zealand Threat Classification System in 2019 (Baker et al 2019)). Between 2002–03 and 2019–20, there were 198 observed captures of whales and dolphins in jack mackerel trawl fisheries: common dolphin (183), long-finned pilot whale (13), dusky dolphin (1), and long-beaked common dolphin (1). Estimated captures for 2002–03 to 2019–20 are shown in Table 8, and show a strong declining trend. Common dolphins were observed captured off the Taranaki coast or off the west coast of the North Island (Abraham et al 2016, 2021). The 2002–03 to 2017–18 average of the estimated capture rate for common dolphins is 1.5 captures per 100 tows (range 0 to 4.62) in the jack mackerel fishery.

#### 4.3.2 Seabird captures

Annual observed seabird capture rates ranged from 0 to 1.4 per 100 tows in jack mackerel fisheries between 2002–03 and 2019–20 (Abraham & Thompson 2009, Abraham & Thompson 2011, Thompson et al 2013, Abraham et al 2016). Capture rates have fluctuated without obvious trend at this low level (Table 9). Total estimated seabird captures in the jack mackerel trawl fishery varied from 3 to 27 between 2002–03 and 2019–20 (Table 9).

Observed seabird captures since 2002–03 have been mostly prions, shearwaters, and petrels (83 of the 111 observed seabird captures), with 28 observed albatross captures (Table 10). Seabird captures in the jack mackerel fishery have been observed mostly on the Stewart-Snares shelf, off Taranaki, and off the east coast South Island. These numbers should be regarded as only a general guide on the distribution of captures because the numbers are small, and the observer coverage is not uniform across areas and may not be representative.

The jack mackerel target trawl fishery contributes to the total risk posed by New Zealand commercial fishing to seabirds (Table 11). The species to which the fishery poses the most risk is Southern Buller's albatross; this target fishery posing 0.002 of PST (Table 11). Southern Buller's albatross was assessed at high risk (Richard et al 2017).

Mitigation methods such as streamer (tori) lines, Brady bird bafflers, warp deflectors, and offal management are used in the jack mackerel trawl fishery. Warp mitigation was voluntarily introduced from about 2004 and made mandatory in April 2006 (Department of Internal Affairs 2006). The 2006 Notice mandated that all trawlers over 28 m in length use a seabird scaring device while trawling ("paired streamer lines", "bird baffler" or "warp deflector" as defined in the Notice).

**Table 8: Number of tows by fishing year and observed common dolphin captures in jack mackerel trawl fisheries, 2002–03 to 2019–20. Annual fishing effort (tows), number of observed tows and observer coverage (%) in jack mackerel trawl fisheries; number of observed captures and observed capture rate (captures per hundred tows) of common dolphin; estimated captures and capture rate of common dolphin (mean and 95% credible interval). Estimates are based on methods described by Abraham et al (2021), available online at https://protectedspeciescaptures.nz/PSCv6/released/. Observed and estimated protected species captures in this table derive from the PSC database version PSCV6.**

| | Fishing effort | | | Obs. captures | | Est. captures | | Est. capture rate | |
|---|---|---|---|---|---|---|---|---|---|
| Fishing year | Tows | No. Obs | % obs | Captures | Rate | Mean | 95% c.i. | Mean | 95% c.i. |
| 2002–03 | 3 067 | 346 | 11.3 | 21 | 6.07 | 141 | 60-259 | 4.59 | 1.96-8.44 |
| 2003–04 | 2 383 | 152 | 6.4 | 17 | 11.18 | 99 | 45-181 | 4.17 | 1.89-7.6 |
| 2004–05 | 2 509 | 558 | 22.2 | 21 | 3.76 | 85 | 46-139 | 3.39 | 1.83-5.54 |
| 2005–06 | 2 809 | 709 | 25.2 | 2 | 0.28 | 12 | 2-33 | 0.43 | 0.07-1.17 |
| 2006–07 | 2 711 | 802 | 29.6 | 11 | 1.37 | 55 | 23-102 | 2.04 | 0.85-3.76 |
| 2007–08 | 2 652 | 818 | 30.8 | 20 | 2.44 | 42 | 24-70 | 1.60 | 0.9-2.64 |
| 2008–09 | 2 169 | 813 | 37.5 | 11 | 1.35 | 23 | 11-43 | 1.05 | 0.51-1.98 |
| 2009–10 | 2 406 | 786 | 32.7 | 4 | 0.51 | 17 | 4-42 | 0.69 | 0.17-1.75 |
| 2010–11 | 1 882 | 593 | 31.5 | 7 | 1.18 | 53 | 18-108 | 2.82 | 0.96-5.74 |
| 2011–12 | 2 032 | 1 548 | 76.2 | 5 | 0.32 | 7 | 5-13 | 0.32 | 0.25-0.64 |
| 2012–13 | 2 213 | 1 940 | 87.7 | 15 | 0.77 | 16 | 15-20 | 0.71 | 0.68-0.9 |
| 2013–14 | 2 447 | 2 187 | 89.4 | 28 | 1.28 | 29 | 28-35 | 1.21 | 1.14-1.43 |
| 2014–15 | 1 750 | 1 512 | 86.4 | 19 | 1.26 | 21 | 19-28 | 1.21 | 1.09-1.6 |
| 2015–16 | 1 544 | 1 383 | 89.6 | 2 | 0.14 | 3 | 2-7 | 0.17 | 0.13-0.45 |
| 2016–17 | 1 407 | 1 024 | 72.8 | 0 | 0.00 | 1 | 0-5 | 0.05 | 0-0.36 |
| 2017–18 | 1 688 | 1 474 | 87.3 | 0 | 0.00 | 0 | 0-4 | 0.03 | 0-0.24 |
| 2018–19 | 1 627 | 1 278 | 78.5 | 0 | 0.00 | | | | |
| 2019–20 | 1 747 | 1 352 | 77.4 | 0 | 0.00 | | | | |

**Table 9: Number of tows by fishing year and observed seabird captures in jack mackerel trawl fisheries, 2002–03 to 2019–20. No. obs, number of observed tows; % obs, percentage of tows observed; Rate, number of captures per 100 observed tows. Estimates are based on methods described by Abraham & Richard (2020) and are available online at https://protectedspeciescaptures.nz/PSCv6/released/. Observed and estimated protected species captures in this table derive from the PSC database version PSCV6.**

| | Fishing effort | | | Obs. captures | | Est. captures | | Est. capture rate | |
|---|---|---|---|---|---|---|---|---|---|
| Fishing year | Tows | No. Obs | % obs | Captures | Rate | Mean | 95% c.i. | Mean | 95% c.i. |
| 2002–03 | 3 067 | 346 | 11.3 | 4 | 1.16 | 22 | 10-42 | 0.72 | 0.33-1.37 |
| 2003–04 | 2 383 | 152 | 6.4 | 0 | 0.00 | 7 | 1-17 | 0.29 | 0.04-0.71 |
| 2004–05 | 2 509 | 558 | 22.2 | 8 | 1.43 | 16 | 9-27 | 0.63 | 0.36-1.08 |
| 2005–06 | 2 809 | 709 | 25.2 | 0 | 0.00 | 20 | 5-45 | 0.70 | 0.18-1.6 |
| 2006–07 | 2 711 | 802 | 29.6 | 1 | 0.12 | 8 | 2-19 | 0.31 | 0.07-0.7 |
| 2007–08 | 2 652 | 818 | 30.8 | 1 | 0.12 | 9 | 2-20 | 0.32 | 0.08-0.75 |
| 2008–09 | 2 169 | 813 | 37.5 | 6 | 0.74 | 14 | 7-26 | 0.63 | 0.32-1.2 |
| 2009–10 | 2 406 | 786 | 32.7 | 9 | 1.15 | 15 | 9-27 | 0.63 | 0.37-1.12 |
| 2010–11 | 1 882 | 593 | 31.5 | 7 | 1.18 | 15 | 8-28 | 0.78 | 0.43-1.49 |
| 2011–12 | 2 032 | 1 548 | 76.2 | 6 | 0.39 | 9 | 6-18 | 0.47 | 0.3-0.89 |
| 2012–13 | 2 213 | 1 940 | 87.7 | 26 | 1.34 | 27 | 26-31 | 1.22 | 1.17-1.4 |
| 2013–14 | 2 447 | 2 187 | 89.4 | 7 | 0.32 | 7 | 6-13 | 0.30 | 0.25-0.53 |
| 2014–15 | 1 750 | 1 512 | 86.4 | 12 | 0.79 | 14 | 12-22 | 0.81 | 0.69-1.26 |
| 2015–16 | 1 544 | 1 383 | 89.6 | 6 | 0.43 | 7 | 6-12 | 0.47 | 0.39-0.78 |
| 2016–17 | 1 407 | 1 024 | 72.8 | 4 | 0.39 | 6 | 4-13 | 0.45 | 0.28-0.92 |
| 2017–18 | 1 688 | 1 474 | 87.3 | 10 | 0.68 | 11 | 10-16 | 0.67 | 0.59-0.95 |
| 2018–19 | 1 627 | 1 278 | 78.5 | 3 | 0.23 | 5 | 3-10 | 0.28 | 0.18-0.61 |
| 2019–20 | 1 747 | 1 352 | 77.4 | 1 | 0.07 | 3 | 1-9 | 0.16 | 0.06-0.52 |

**Table 10: Number of observed seabird captures in jack mackerel trawl fisheries, 2002–03 to 2019–20, by species and area. Observed protected species captures in this table derive from the PSC database version PSCV6.**

| Species | Risk category | Taranaki | WCNI | Chatham Rise | Stewart-Snares shelf | ECSI | WCSI | Total |
|---|---|---|---|---|---|---|---|---|
| Salvin's albatross | High | 0 | 0 | 0 | 0 | 3 | 0 | 3 |
| Southern Buller's albatross | High | 0 | 0 | 1 | 3 | 2 | 0 | 6 |
| New Zealand white-capped albatross | Medium | 5 | 0 | 0 | 10 | 4 | 0 | 19 |
| **Total albatrosses** | – | 5 | 0 | 1 | 13 | 9 | 0 | 28 |
| Westland petrel | High | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| White-chinned petrel | Negligible | 0 | 0 | 1 | 32 | 5 | 0 | 38 |
| Sooty shearwater | Negligible | 1 | 0 | 0 | 10 | 2 | 0 | 13 |
| Common diving petrel | Negligible | 0 | 0 | 0 | 1 | 0 | 1 | 2 |
| White-faced storm petrels | Negligible | 0 | 3 | 1 | 0 | 0 | 0 | 4 |
| Australasian gannet | Negligible | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| Fairy prion | Negligible | 5 | 0 | 0 | 1 | 1 | 0 | 7 |
| Cape petrels | – | 2 | 0 | 0 | 0 | 0 | 1 | 3 |
| Cook’s petrel | – | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| Fulmar prion | – | 10 | 0 | 0 | 0 | 0 | 0 | 10 |
| Grey-backed storm petrel | – | 1 | 0 | 1 | 0 | 0 | 0 | 2 |
| Large seabird | – | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| **Total other birds** | – | 22 | 3 | 3 | 44 | 8 | 3 | 83 |

**Table 11: Risk ratio of seabirds predicted by the level two risk assessment for the jack mackerel and all fisheries included in the level two risk assessment, 2006–07 to 2016–17, showing seabird species with a risk ratio of at least 0.001 of PST (Richards et al 2020). 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 shown (Robertson et al 2017 at http://www.doc.govt.nz/documents/science-and-technical/nztcs19entire.pdf).**

| | | Risk ratio | | | |
|---|---|---|---|---|---|
| Species name | PST (mean) | MAC risk ratio | Total | Risk category | DOC Threat Classification |
| Southern Buller's albatross | 1 368.4 | 0.002 | 0.392 | High | At Risk: Naturally Uncommon |
| New Zealand white-capped albatross | 10 900.3 | 0.001 | 0.353 | High | At Risk: Declining |

### 4.3.3 Protected fish species captures

Mobulid rays (spinetail devilrays, *Mobula mobular*, and manta rays, *Mobula birostris,* both protected since 2010 under the Wildlife Act 1953) occur mainly in north-eastern North Island waters during summer and could potentially be caught in purse seine nets along the north-east coast of North Island. However, observers monitoring mackerel purse seine fisheries (coverage 0–17.8% per year, 2002–18) have not reported any captures of mobulid rays to date.

## 4.4 Benthic interactions

Jack mackerel are taken using trawls that are sometimes fished on or near the seabed. The spatial extent of seabed contact by trawl fishing gear in New Zealand's EEZ and Territorial Sea has been estimated and mapped in numerous studies for trawl fisheries targeting deepwater species (Baird et al 2011, Black et al 2013, Black & Tilney 2015, Black & Tilney 2017, Baird & Wood 2018, and Baird & Mules 2019, 2021a, 2021b), species in waters shallower than 250 m (Baird et al 2015, Baird & Mules 2021a, 2021b), and all trawl fisheries combined (Baird & Mules 2021a, 2021b). The most recent assessment of the deepwater trawl footprint was for the period 1989–90 to 2020-21 (MacGibbon & Mules 2023).

During 1989–90 to 2020-21, about 57 200 bottom-contacting jack mackerel trawls were reported on TCEPRs and ERS (MacGibbon & Mules 2023); this represents about 1200–3300 tows in most years up to 2013–14 and an average of 930 tows per year from 2014–15 to 2020–21. The total footprint generated from these tows was estimated at about 49 923 km$^2$. This footprint represented coverage of 1.2% of the seafloor of the combined EEZ and the Territorial Sea areas; 3.6% of the 'fishable area', that is, the seafloor area open to trawling, in depths of less than 1600 m. For the 2020-21 fishing year, 1027 jack mackerel bottom-contacting tows had an estimated footprint of 2818 km$^2$ which represented coverage of 0.1% of the EEZ and Territorial Sea and 0.2% of the fishable area (MacGibbon & Mules 2023).

The overall trawl footprint for jack mackerel (1989–90 to 2020-21) covered 16% of the seafloor in < 200 m, 6% of 200–400 m seafloor, and < 0.05% of the 400–600 m seafloor (Baird & Mules 2021b). The jack mackerel footprint contacted 1%, 0.1%, and < 0.01% of those depth ranges, respectively, in 2020–21 (MacGibbon & Mules 2023). The BOMEC class C (off the west coast of the North Island) had the highest proportion of area covered by the jack mackerel footprint in 2018–19 (4%), with the remainder of the footprint covering about 0.3% of the 61 000 km$^2$ of class E (Stewart-Snares shelf) and 0.2% of the 138 550 km$^2$ of class H (Chatham Rise) (Baird & Mules 2021b).

Trawling for jack mackerel with some or all of the gear contacting the bottom, like trawling for other species, is likely to have effects on benthic community structure and function (e.g., 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 may disrupt spawning activity or success. Canadian research carried out on Atlantic cod (*Gadus morhua*) concluded that "Cod exposed to a chronic stressor are able to spawn successfully, but there appears to be a negative impact of this stress on their reproductive output, particularly through the production of abnormal larvae" (Morgan et al 1999). Morgan et al (1997) also reported disruption of a spawning shoal of Atlantic cod: "Following passage of the trawl, a 300-m-wide "hole" in the aggregation spanned the trawl track. Disturbance was detected for 77 min after passage of the trawl." There have been no specific studies for jack mackerel in New Zealand waters, but information on the timing and location of spawning and fishing exists. *T. declivis* and *T. novaezelandiae* are serial spawners with a protracted spring-summer spawning season (Hurst et al 2000). *T. murphyi* appears to spawn from late winter through to summer (Horn 1991b, Hurst et al 2000). The JMA 7 trawl fishery has peaks of catch and effort in spring-summer (October–March) and in winter (April–September) (McKenzie 2008), the former overlapping with spawning. Most of the purse seine catch from the Bay of Plenty is taken in September–October, but an increasing proportion has been caught in November–December since 2005–06 (Walsh et al 2012), also overlapping the spring-summer spawning.

#### 4.5.2 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 2016), although work is underway to generate one. Studies of potential relevance have identified areas of importance for spawning and juveniles (Hurst et al 2000). *T. declivis* spawning was found to be common on the southwest and northwest North Island outer shelf, and moderate to high abundance of juveniles was recorded from northwest North Island, Hauraki Gulf, and Bay of Plenty outer shelf. *T. novaezelandiae* spawning was found to be common on the southwest and northwest inner and outer shelf of the North Island, and moderate to high abundance of juveniles was recorded from Hauraki Gulf and Bay of Plenty inner and outer shelf, East Cape inner shelf, and Tasman Bay/Golden Bay. *T. murphyi* spawning was found to be common on the southwest outer shelf and only low abundance of juveniles was recorded from the outer Southland shelf and at 300–600 m on the Chatham Rise.

#### 4.5.3 Genetic effects

Fishing and environmental changes, including those caused by climate change or pollution, could alter the genetic composition or diversity of a species. There are no known studies of the genetic diversity of jack mackerels in New Zealand.

#### 4.5.4 Marine heatwave

The effects of the marine heatwave on jack mackerel fisheries that was experienced in New Zealand waters in the summer months of 2017–18 are unknown.

## 5. STOCK ASSESSMENT

Stock assessments for jack mackerel are complicated by the reporting and management of three species under a single code.

### 5.0 Central East, and Auckland East (JMA 1)

The catch sampling programme used to estimate species composition in the JMA 1 purse seine fishery was extended during the 2019–20 and 2020–21 fishing years to collect catch-at-age data from sampled landings that included catches of *T. novaezelandiae* (Hartill et al 2022). The catch-at-age distributions for the two fishing years showed a consistent pattern in year class strength, with a progression of strong and weak year classes seen between the two years. Chapman-Robson total mortality estimates calculated from these two age distributions, for a range of assumed ages at recruitment, were similar between years (Table 12).

**Table 12: Chapman-Robson total mortality estimates for alternative ages at full recruitment by fishing year. Bootstrap coefficients of variation are in parentheses (Hartill et al 2022).**

| Age at recruitment | 2019–20 | 2020–21 |
|---|---|---|
| 3 | 0.206 (0.06) | 0.232 (0.11) |
| 4 | 0.247 (0.06) | 0.290 (0.12) |
| 5 | 0.302 (0.06) | 0.290 (0.10) |
| 6 | 0.356 (0.05) | 0.331 (0.09) |

**Establishing $B_{MSY}$-compatible reference points**

The Inshore Fisheries Assessment Working Group adopted $F = 0.87 \times M = 0.157$ as an $F_{MSY}$ proxy target fishing mortality rate, based on the meta-analysis of Zhou et al (2012). This is based on M of 0.18.

### 5.1 Challenger, Central West, and Auckland West (JMA 7)

Preliminary stock assessments for *T. declivis* and *T. novaezealandiae* in JMA 7 were undertaken in 2007 (McKenzie 2009). These relied on CPUE indices (McKenzie, 2008) where an average species composition was applied to individual tows within a stratum. Webber & Starr (2022) noted that applying average species proportions across relatively large strata to individual tows, instead of using the actual species proportions in the tow, will reduce the variability in a CPUE analysis and will likely lead to biased coefficient estimates because the model does not have access to the real variation by species relative to the covariate values. As a result, these previous CPUE analyses and the preliminary assessments are considered unreliable.

Webber & Starr (2022) also identified a range of concerns about the data from observer sampling in JMA 7. Consequently, a set of CPUE standardisations of all three species combined was carried out, for positive catches of JMA only.

**Species proportion sampling**
The key concern identified by Webber & Starr (2022) was that observer sampling for catch composition in the JMA 7 trawl fishery had not always been implemented as specified in the observer manual. There were reports which suggested that observers often took a single sample at the beginning of processing instead of several throughout the processing procedure. They suggested that if stratification of the catch within the trawl persisted through to when the catch was processed, then sampling at a single time would result in biased estimates of species composition.

The existing data collection procedures did not retain sub-sample information for jack mackerel length-frequency samples by species, so there was no way of using these data to assess whether the fish comprising a sample were collected at one time or as a series of sub-samples. To address concerns about potential stratification in the sampled catch, two observer trips were carried out where observers took up to four speciated length-frequency sub-samples of jack mackerel during the processing of catches and recorded the sub-sample data separately. Middleton (2022) found differences between some sub-sample and tow-level estimates of species proportions, but these were not related to the time during processing when sub-samples were taken. As a result, it was concluded by the WG that there was only a limited risk of bias in tow-level estimates of species composition arising from sampling at a single point during processing.

**Misidentification of species**
Misidentification of the three jack mackerel species in observer sampling of otoliths for ageing has been apparent in catch-at-age data from the JMA 7 fishery for some time. Based on the subset of fish aged, Saunders et al (2022) reported that the rate of misidentification by observers was at least 8% for *T. novaezelandiae* and at least 3% for *T. declivis*. While potential misidentification was sometimes apparent in length sampling data (e.g., a small number of suspiciously large *T. novaezelandiae*), instances of misidentification tended to stand out most obviously in plots of length at age, from age sampling. However, even in these data, misidentification was only clear for older fish (i.e., when the growth curves were obviously separated) whereas some level of misidentification would also be expected for smaller fish.

Moore et al (2024) have demonstrated that analyses of otolith shape showed promise for confirming the species for fish selected for ageing. To address this issue using the existing data, Neubauer & Middleton (in prep) developed a Bayesian mixture model of growth and fitted this model to age-length data for jack mackerels sampled in JMA 7 from 1995 to 2020. The 18 987 observations had a measured fork length, an age from otolith reading, and an observer-assigned species. The mixture model estimated the von Bertalanffy growth parameters for each species (combined sexes) and made predictions of the true species for each observation, accounting for potential ageing error (Figure 3).

The mixture model results have been used to provide updated estimates of growth parameters for *T. novaezelandiae* and *T. declivis* in JMA 7 (Table 6) but also provided information on the probability that the observer-assigned species was correct (Figure 4). The latter estimates allowed an investigation of the sensitivity of species-specific CPUE indices to species misidentification (see below). For each fish, the model provided an estimate of the probability that a particular fish should be assigned to a particular species. Because the growth curve for *T. declivis* lies between that of the other two species, the model tended to be less confident about species assignment for these fish. Using a threshold for likely misidentification of < 50% probability (that the observer-assigned species was correct, given the model) for *T. novaezelandiae* and *T. murphyi*, and < 25% for *T. declivis*, led to estimated misidentification rates of 8.3% for *T. declivis*, 5.9% for *T. novaezelandiae* and < 1% for *T. murphyi*.

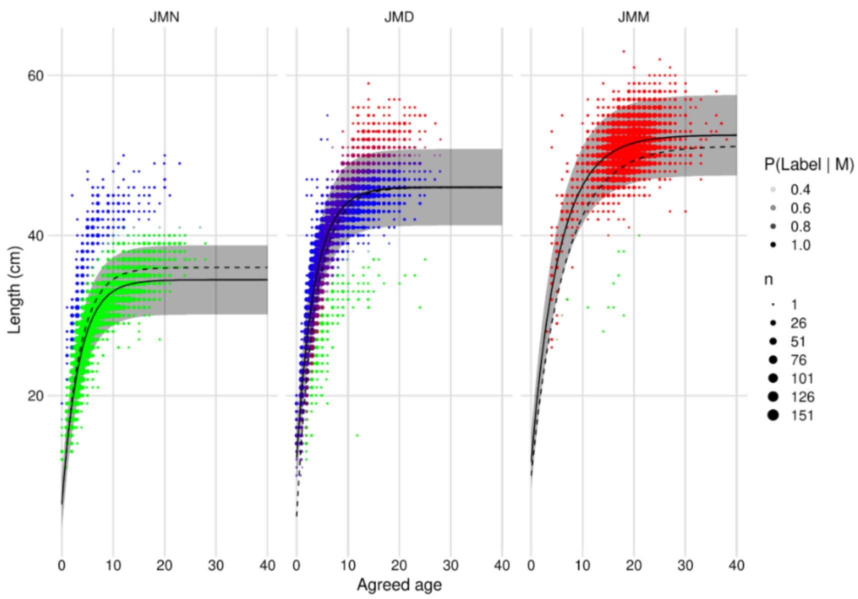



**Figure 3: Estimated growth curves for jack mackerels in JMA 7 (JMN, *T. novaezelandiae*; JMD, *T. declivis*; JMM, *T. murphyi*). Solid lines indicate the median and 95% interval for predicted size at age, in comparison to the growth curves based on parameters previously reported in the Plenary (dashed lines). The three panels group the data according to the observer assigned species, and points are coloured by the model predicted species (JMN = green, JMD = blue, JMM = red), and shaded by the estimated probability of that prediction.**

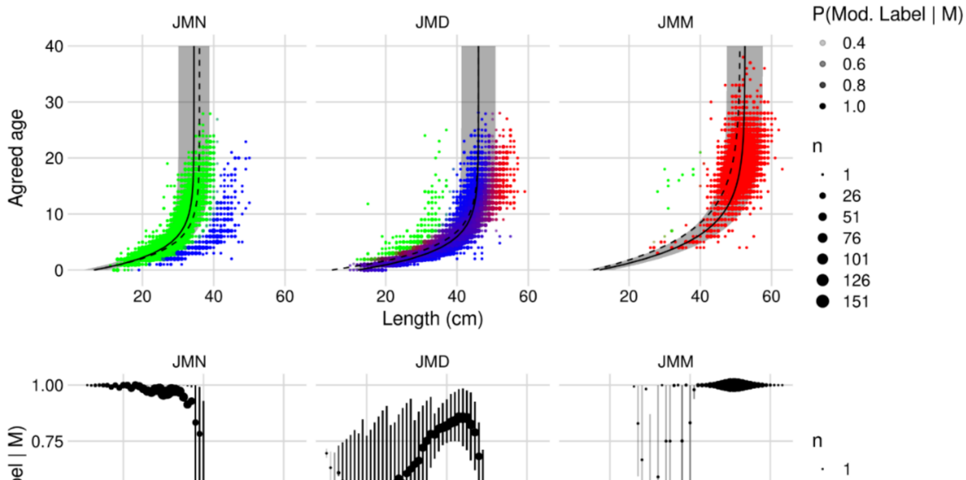



**Figure 4: Top: estimated growth curves for jack mackerel species in JMA 7 plotted as agreed age, from the otolith readings, at measured size and with panels grouping the data by observer-assigned species (JMN, *T. novaezelandiae*; JMD, *T. declivis*; JMM, *T. murphyi*). Solid lines indicate the median and 95% interval for predicted size at age, in comparison to the growth curves based on parameters previously reported in the Plenary (dashed lines), and points are coloured by the model predicted species (JMN = green, JMD = blue, JMM = red), and shaded by the estimated probability of that prediction. Bottom: median (points) and 95% interval (lines) for the probability that the observer assigned species label is correct, given the model predicted species, grouped by 1 cm length intervals.**

## CPUE

Species-specific CPUE indices for *T. declivis* and *T. novaezealandiae* in JMA 7 were revisited in 2022, following the work to address concerns about the impacts of observer sampling on tow-level species composition estimates (Middleton 2022).

For observed tows with length-frequency sampling of jack mackerels, the observer sampling was used to estimate the proportion of each species in the tow, by weight after applying the standard length-weight relationships (Table 6) to estimate the weight of each sampled fish. These proportions were then applied to disaggregate the observer-recorded total weight of jack mackerels in the tow into a tow-by-tow catch by species (Figure 5). Where an observer had recorded catch weights using a species-specific code (i.e., JMD, JMM, or JMN), these weights were first recoded to the generic jack mackerel code (JMA) and aggregated at the tow level.

Standardised CPUE indices were calculated using standard maximum-likehood methods for each species individually. Data were restricted to tows where the observer recorded that jack mackerel was the target species. Two series were considered: (i) midwater tows only (MW series), which allowed annual indices to be estimated from 1999, and (ii) using both bottom and midwater tows (TR series), which allowed indices to be estimated from 1991.

For *T. novaezelandiae* tows were restricted to the Taranaki Bight and west coast of the North Island (Statistical Areas 037, 039, 040, 041, 042, and 045) while the datasets for *T. declivis* also included tows off the South Island west coast (Statistical Areas 034, 035, and 036). Core fleet selection required vessels to have at least one observed trip in a minimum of four fishing years for the midwater series, but—due to lower observer coverage in the early 1990s—this was reduced to a minimum of two years for the longer TR series in order to maximise the number of observations. Stepwise selection on the basis of AIC, retaining terms only if they explained an additional 1% of the deviance, was used to select covariates, with fishing year, vessel, month, and statistical area offered as categorical terms (with method added for the TR series) and duration, start time, seabed depth, headline height, and fishing speed offered as continuous terms using natural spline smoothers.

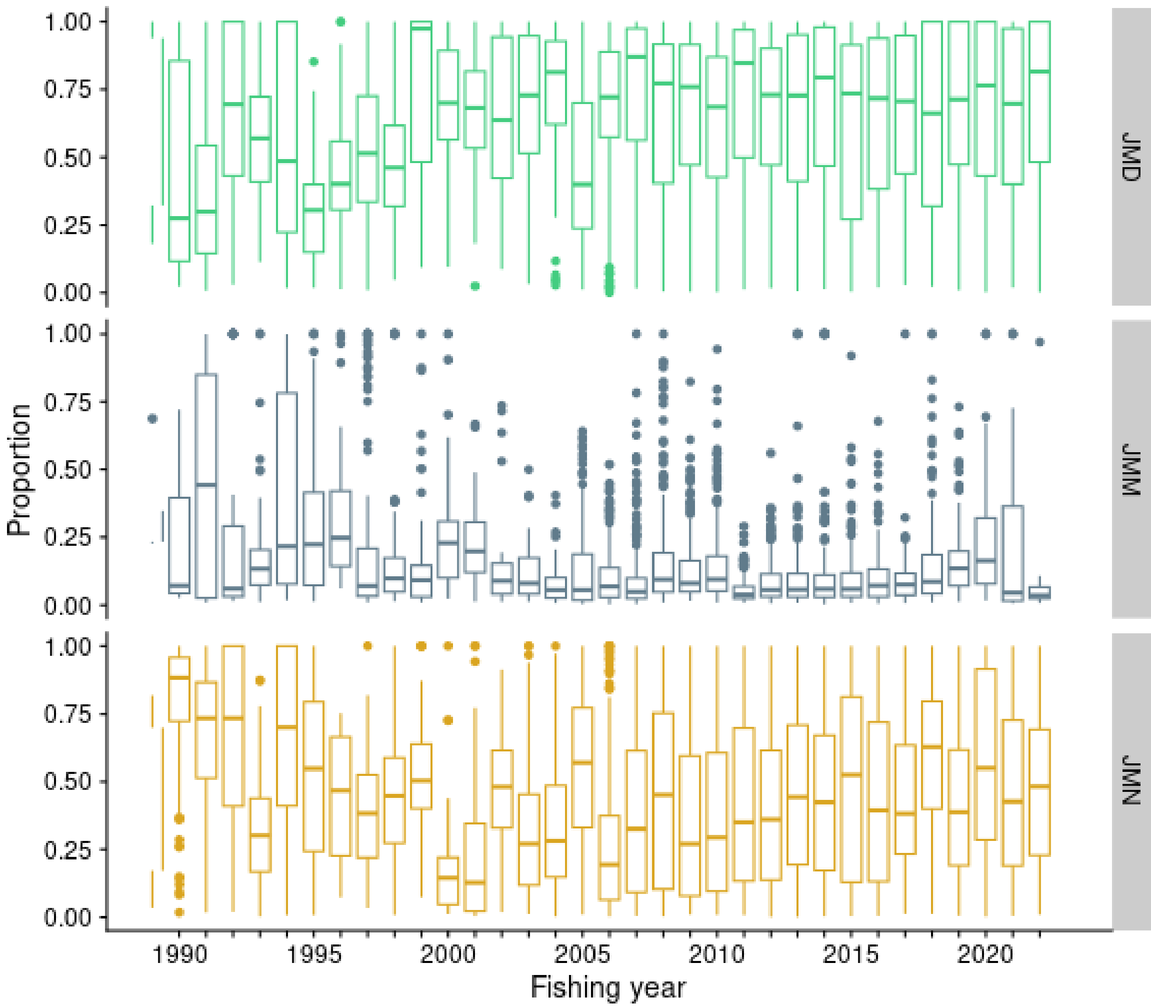



**Figure 5: Annual boxplots of tow-level proportions of each jack mackerel species (JMN, *T. novaezelandiae*; JMD, *T. declivis*; JMM, *T. murphyi*) from observer sampling in JMA 7. Tows are plotted if the length frequency sample contained at least 30 fish.**

*Trachurus declivis* occurred in a high proportion of tows, reaching 100% in some years and precluding estimation of an occurrence model. For *T. novaezealandiae* both an occurrence and positive catch models were fitted, and a combined index was calculated. For the MW series, vessel was not selected as an explanatory variable for catches of either species, an outcome which was likely attributable to the fact that the core fleets comprised only the very similar BATM-class vessels. The temporal trends evident in the indices for *T. declivis* and *T. novaezealandiae* were similar among the statistical areas included in the models for each species, indicating that it was unlikely that there was an area-year interaction in this analysis.

The following sensitivity analyses were considered:

- the impact of including or excluding tows where the length-frequency sample size was unusually small (less than 30 fish);
- the effect of excluding trips with apparent observer misidentifications of jack mackerel species;
- whether the subset of observer data with length-frequency sampling produced a biased index relative to the entire fleet data; and
- whether there was any evidence for 'effort creep' (i.e., increased catching efficiency over time) in the core fleet vessels.

None of these sensitivities indicated significant problems with the standardised CPUE analyses, and the MW series beginning in 1999 was accepted by the Deepwater Working Group as indices of abundance for *T. declivis* and *T. novaezealandiae* in JMA 7 (Figure 6). The longer TR (MW+BT) series, beginning in 1991, was not considered sufficiently reliable to provide a longer term series, primarily because the level of observer coverage was much lower in the early 1990s but also because of the fact that the vessels fishing in the early 1990s had largely exited the fishery by the end of that decade with almost no overlap with the post-1999 fishery.

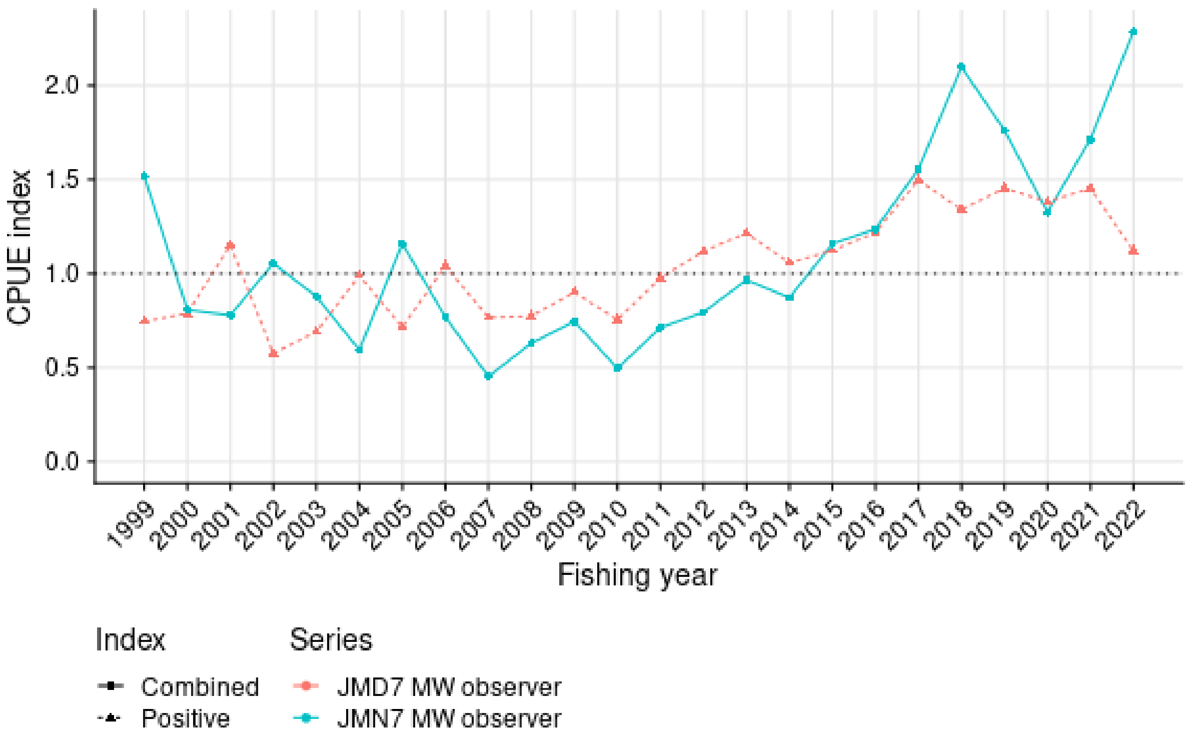



**Figure 6: Standardised catch per unit effort (CPUE) indices for *T. declivis* (JMD) and *T. novaezealandiae* (JMN) in JMA 7 calculated from observer data using the subset of tows where length-frequency sampling permitted estimation of catch by species. A positive catch index is presented for JMD and a combined index (binomial/positive) index for JMN. The series are scaled to have a geometric mean of 1.**

### Establishing $B_{MSY}$-compatible reference points

In 2022, the Deepwater Working Group (DWWG) considered that there was little information available to allow equating a particular period with a specific stock status for either of the two native jack mackerel species. Commercial fisheries became established in JMA 7 in the 1970s, but catches were lower than in recent decades, and there was no indication that the stocks were depleted when jack mackerels entered the QMS. The DWWG noted that the Harvest Strategy Standard Operational Guidelines propose that, in cases where the relationship between CPUE and abundance can be assumed to be more or less proportional, it was reasonable to select an appropriate historical period when both CPUE and catches were relatively high and stable and to use this CPUE level as a target (conceptual $B_{MSY}$). Catches in JMA 7 were considered to have been stable since the early-mid 2000s, with the establishment of the BATM fleet. Periods of stable abundance were identified as 2004–2011 for *T. declivis* and 2006–2012 for *T. novaezealandiae.* Noting that both species had subsequently increased in abundance while combined species catches remained stable, the Plenary adopted the geometric mean CPUE in each of these periods as the target reference level for the appropriate species (equated to 35% $B_0$ for these medium-productivity species). The soft limit (20% $B_0$) was set at 4/7 of the mean value for each period and the hard limit (10% $B_0$) was set at 2/7 of the mean value by period.

**Catch at Age**

Catch-at-age distributions for all three jack mackerel species JMA 7 are available for 1989–90, 1990–91, 1995–96, 2004–05, and 2005–06 to 2020–21 (e.g., Saunders et al 2022). However, the DWWG noted that apparent strong year classes evident in the length -frequency distributions did not clearly translate to the age distributions, which were prepared using a standard method developed in 2011 with a stratification updated in 2016. The Working Group considered that the methodology for preparing age frequency distributions would require re-evaluation before these were used for stock assessment.

**Future Research Considerations – JMA7**

- Extend the mixture modelling of length at age data to allow evaluation of whether significant sex or area specific differences in growth are present for any species.
- Explore using otolith shape analysis to validate the potential misidentification from the mixture modelling.
- Explore whether there are temporal trends in species misidentification.
- Evaluate the methodology and stratification, and provide time series of catch by species (e.g., bootstrapping vs model-based approaches) and consider whether the estimation of species composition and CPUE can be usefully integrated.
- Review the methodology used to create annual age frequency distributions, including the stratification used.
- Review available data on JMA 7 from west coast inshore trawl surveys to determine what additional information on trends in abundance and recruitment this can provide.
- Explore available information to investigate whether there are any temporal patterns in mean size for each species, and consider how these can inform our understanding of the stocks.
- Given the likely correlation between observer samples collected within the same trip, explore the representativeness of observer sampling at the trip level rather than event level.

## 5.2 Biomass estimates

Estimates of current biomass are not available.

## 5.3 Other yield estimates and stock assessment results

For *T. declivis* and *T. novaezealandiae* catch-at-age proportions were used to estimate instantaneous total mortality *Z* for the years 2006–07 to 2008–09 in JMA 7 (Smith 2011). The methods used to produce species-specific catch-at-age distributions for JMA 7 are not currently considered sufficiently reliable to use these results.

## 5.4 Other factors

*Trachurus murphyi* has been known at times to comprise a substantial proportion of the purse seine catches in the area between Cook Strait and Kaikōura, in the Bay of Plenty, and off the east Northland coast, although the proportion of this component has declined considerably since the late 1990s. *Trachurus murphyi* has also been an important component of the west coast North Island jack mackerel trawl fishery but has declined in recent years. Thus, there has been a contraction in the range of this species in New Zealand waters, although it is unknown yet whether this represents a decrease in its overall abundance here. The effect of *T. murphyi* on the range and abundance of the other two species is unknown.

Aerial sightings data were used to produce a time series of relative abundance indices for jack mackerel. The time series covered the period from the beginning of the purse seine fishery in 1976 to 1993. It indicated an increase in abundance in JMA 1 from the early 1990s, and, although the result was not as clear, a similar trend in JMA 3 and JMA 7. These increases were attributed to the invasion of *T. murphyi.*

Efforts to produce aerial sightings based abundance indices for jack mackerel were discontinued as the species were not separated in the data (Taylor 2014).

The stipulation that catches in JMA 1 and JMA 3 above the original TACs (5970 t and 2700 t, respectively) be accounted for by increases in *T. murphyi* only, is a method of managing this species independently of the other two. This approach was introduced as a means of maintaining stocks of the endemic species while allowing exploitation of increased stocks of *T. murphyi* resulting from its invasion.

The increase in *T. novaezelandiae* catch has predominantly occurred within the Bay of Plenty fishery area. There has been a small decrease in the length of fish caught from the fishery since 2006–07 to 2008–09, although it is unknown whether the decline in fish size is attributable to an increase in fishing mortality rates, changes in fishing operation, or variation in annual recruitment.

**Future Research Considerations for all stocks**

- The instruction that observers (for JMA 3 and JMA 7) routinely aim to spread the collection of length-frequency samples of jack mackerels throughout the processing period should be maintained; the observer data base should be extended to capture information about the sub-sampling achieved from the processing of each tow.
- Consider the introduction of simpler species composition sampling (proportion by weight) for observed tows that are not selected for length-frequency sampling.
- Review of JMD and JMN stock structure and evaluation of the occurrence and extent of *T. murphyi* incursions into NZ waters, including a national scale characterisation of JMA. This should also review older documents describing the JMA fisheries and stocks.

## 6. STATUS OF THE STOCKS

**Stock Structure Assumptions**

Separate stocks of *T. declivis* (JMD) and *T. novaezealandiae* (JMN) are assumed to occur in each jack mackerel Quota Management Area (other than JMA 10). *T. murphyi* (JMM) in New Zealand waters is not considered to represent an independent biological stock.

- **JMA 1 -** *T. novaezealandiae*

| **Stock Status** | | |
|---|---|---|
| Most Recent Assessment Plenary Publication Year | 2023 | |
| Catch in most recent year of assessment | Year: 2020–21 | Catch: 5 581 t |
| Assessment runs presented | Estimates of fishing mortality for 2019-20 and 2020-21 | |
| Reference Points | Target(s): $F_{MSY}$ proxy = 0.87x$M$ = 0.157<br>Soft Limit: 20% $B_0$<br>Hard Limit: 10% $B_0$<br>Overfishing threshold: $F_{MSY}$ proxy = 0.87x$M$ = 0.157 | |
| Status in relation to Target | Likely (> 60%) to at or below the target | |
| Status in relation to Limits | Unknown | |
| Status in relation to Overfishing | Overfishing is Unlikely (<40%) to be occurring | |

| Historical Stock Status Trajectory and Current Status |
|---|
| - |

| Fishery and Stock Trends | |
|---|---|
| Recent Trend in Biomass or Proxy | An abundance index for JMN in JMA 1 is not available. |
| Recent Trend in Fishing Mortality or Proxy | - |
| Trends in other Relevant Indicators or Variables | - |

| Projections and Prognosis | |
|---|---|
| Stock Projections or Prognosis | It is not known whether catches at the level of the current TACCs or recent catch levels are sustainable in the long-term. |
| Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits | Soft Limit: Unknown<br>Hard Limit: Unknown |
| Probability of Current Catch or TACC causing Overfishing to continue or to commence | Unlikely (<40%) for current catch |

| Assessment Methodology and Evaluation | | |
|---|---|---|
| Assessment Type | Level 2— Partial Quantitative Stock Assessment | |
| Assessment Method | Chapman-Robson estimates of total mortality | |
| Assessment Dates | Latest assessment Plenary publication year: 2024 | Next assessment: Unknown |
| Overall assessment quality rank | -1 – High Quality | |
| Main data inputs (rank) | Age composition from sampling of purse seine landings | 1 – High Quality |
| Data not used (rank) | Aerial sightings index | 3 – Low Quality: high-interannual variation |
| Changes to Model Structure and Assumptions | No previously accepted assessment | |
| Major Sources of Uncertainty | The mortality rate estimates do not necessarily represent those experienced by the population of *Trachurus novaezelandiae* throughout JMA 1 because they were derived almost exclusively from purse seine landings taken from the Bay of Plenty. | |

| Qualifying Comments |
|---|
| - |

| Fishery Interactions |
|---|
| JMA 1 catches are primarily taken by targeted purse seine. Because jack mackerel often occur in mixed schools with kahawai, particularly towards the end of the fishing year, this can inhibit jack mackerel targeting in this fishery at this time. |

- **JMA 1 -** *T. declivis*

| Stock Status | | |
|---|---|---|
| Most Recent Assessment Plenary Publication | - | |
| Catch in most recent year of assessment | Year: | Catch: |
| Reference Points | Target(s): Not established but $B_{MSY}$ assumed<br>Soft Limit: 20% $B_0$ | |

| | |
|---|---|
| | Hard Limit: 10% $B_0$<br>Overfishing threshold: Not established |
| Status in relation to Target | Unknown |
| Status in relation to Limits | Unknown |
| Status in relation to Overfishing | - |

| **Historical Stock Status Trajectory and Current Status** |
|---|
| - |

| **Fishery and Stock Trends** | |
|---|---|
| Recent Trend in Biomass or Proxy | An abundance index for JMD  in JMA 1 is not available.. |
| Recent Trend in Fishing Mortality or Proxy | - |
| Trends in other Relevant Indicators or Variables | - |

| **Projections and Prognosis** | |
|---|---|
| Stock Projections or Prognosis | It is not known whether catches at the level of the current TACCs or recent catch levels are sustainable in the long-term. |
| Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits | Soft Limit: Unknown<br>Hard Limit: Unknown |
| Probability of Current Catch or TACC causing Overfishing to continue or to commence | - |

| **Assessment Methodology and Evaluation** | | |
|---|---|---|
| Assessment Type | Level 3—Qualitative Evaluation:  Fishery characterisation with evaluation of fishery trends (e.g., catch, effort and nominal CPUE, length frequency information) – there is no agreed index of abundance | |
| Assessment Method | - | |
| Assessment Dates | Latest assessment Plenary publication year: - | Next assessment: Unknown |
| Overall assessment quality rank | - | |
| Main data inputs (rank) | Species proportions estimates | |
| Data not used (rank) | | |
| Changes to Model Structure and Assumptions | - | |
| Major Sources of Uncertainty | - | |

| **Qualifying Comments** |
|---|
| - |

| **Fishery Interactions** |
|---|
| JMA 1 catches are primarily taken by targeted purse seine. Because jack mackerel often occur in mixed schools with kahawai, particularly towards the end of the fishing year, this can inhibit jack mackerel targeting in this fishery at this time |

- **JMA 3**

| **Stock Status** | | |
|---|---|---|
| Most Recent Assessment Plenary Publication Year | - | |
| Catch in most recent year of assessment | Year: | Catch: |
| Reference Points | Management Target: 40% $B_0$<br>Soft Limit: 20% $B_0$<br>Hard Limit: 10% $B_0$<br>Overfishing threshold: Not established | |
| Status in relation to Target | Unknown | |
| Status in relation to Limits | Unknown | |
| Status in relation to Overfishing | - | |

| **Historical Stock Status Trajectory and Current Status** |
|---|
| **-** |

| **Fishery and Stock Trends** | |
|---|---|
| Recent Trend in Biomass or Proxy | - |
| Recent Trend in Fishing Intensity or Proxy | - |
| Other Abundance Indices | - |
| Trends in Other Relevant Indicators or Variables | - |

| **Projections and Prognosis** | |
|---|---|
| Stock Projections or Prognosis | It is not known whether catches at the level of the current TACCs or recent catch levels are sustainable in the long-term. |
| Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits | Soft Limit: Unknown<br>Hard Limit: Unknown |
| Probability of Current Catch or TACC causing Overfishing to continue or to commence | - |

| **Assessment Methodology and Evaluation** | | |
|---|---|---|
| Assessment Type | Level 4: Low information evaluation—there are only data on catch and TACC, with no other fishery indicators. Catch is qualified with species proportions estimates from MPI observer data. Some length frequency information is available. | |
| Assessment Method | - | |
| | | |
| Assessment Dates | Latest assessment Plenary publication year: - | Next assessment: - |
| Overall assessment quality rank | | |
| Main data inputs (rank) | - | |
| Data not used (rank) | - | |
| Changes to Model Structure and Assumptions | - | |
| Major Sources of Uncertainty | - | |

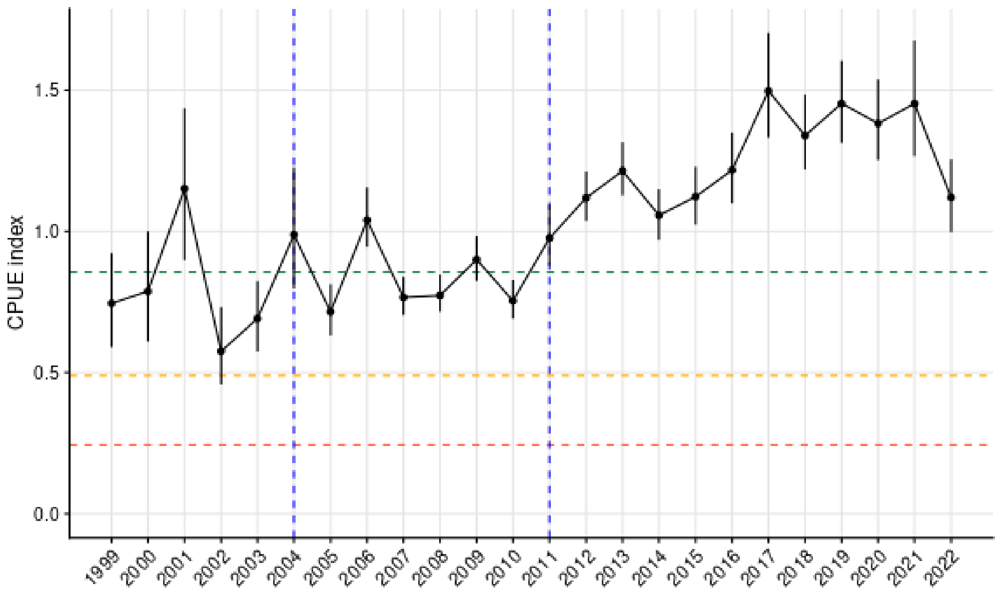
| **Qualifying Comments** |
|---|
| - |

| **Fishery Interactions** |
|---|
| JMA 3 catches are primarily taken by midwater trawl. Non-target species captured in this fishery include barracouta and redbait. Incidental captures of protected species have been recorded for New Zealand fur seals and cetaceans. Trawls on or near the seabed interact with benthic habitats. |

- **JMA 7 -** *T. declivis*

| **Stock Status** | | |
|---|---|---|
| Most Recent Assessment Plenary Publication Year | 2023 | |
| Catch in most recent year of assessment | Year: 2021–22 | Catch: - |
| Assessment Runs Presented | Event resolution CPUE index from observer data from jack mackerel target midwater trawls with length frequency sampling (JMD7 MW observer) | |
| Reference Points | Management Target: 35% $B_0$; the geometric mean CPUE for the period 2004–2011 (a conceptual proxy for $B_{MSY}$)<br>Soft Limit: 20% $B_0$; scaled from management target<br>Hard Limit: 10% $B_0$; scaled from management target<br>Overfishing threshold: not established | |
| Status in relation to Target | Likely (> 60%) to be at or above the target | |
| Status in relation to Limits | Very Unlikely (< 10%) to be be below both the soft and hard limits | |
| Status in relation to Overfishing | Unknown | |

**Historical Stock Status Trajectory and Current Status**




**Positive catch standardised catch per unit effort (CPUE) index for *T. declivis* in JMA 7 (calculated from observer data using the subset of tows where length frequency sampling permits estimation of catch by species) relative to the agreed conceptual reference points. The green, orange, and red dashed lines represent the interim target, soft limit, and hard limit, respectively.**

| **Fishery and Stock Trends** | |
|---|---|
| Recent Trend in Biomass or Proxy | CPUE increased from 2010 to 2017, was stable to 2021, but decreased in 2022 to a level comparable with the mid-2010 period |
| Recent Trend in Fishing Intensity or Proxy | Unknown |
| Other Abundance Indices | - |
| Trends in Other Relevant Indicators or Variables | - |

| **Projections and Prognosis** | |
|---|---|
| Stock Projections or Prognosis | Unknown |
| Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits | Current catch<br>Soft Limit: Unlikely (< 40%) in the short term<br>Hard Limit: Unlikely (< 40%) in the short term |
| Probability of Current Catch or TACC causing Overfishing to continue or to commence | Unknown |

| **Assessment Methodology and Evaluation** | | |
|---|---|---|
| Assessment Type | Level 2 – Partial Quantitative Stock Assessment | |
| Assessment Method | CPUE analysis | |
| Assessment Dates | Latest assessment Plenary publication year: 2023 | Next assessment: 2025 |
| Overall assessment quality rank | 1 – High quality | |
| Main data inputs (rank) | - Observer catch records and length frequency samples | 1 – High Quality |
| Data not used (rank) | - Catch at age | 2 – Medium or Mixed Quality: the methods used for producing scaled catch at age distributions require review |
| Changes to Model Structure and Assumptions | - Species-specific CPUE has replaced a combined species analysis | |
| Major Sources of Uncertainty | - | |

| **Qualifying Comments** |
|---|
| - |

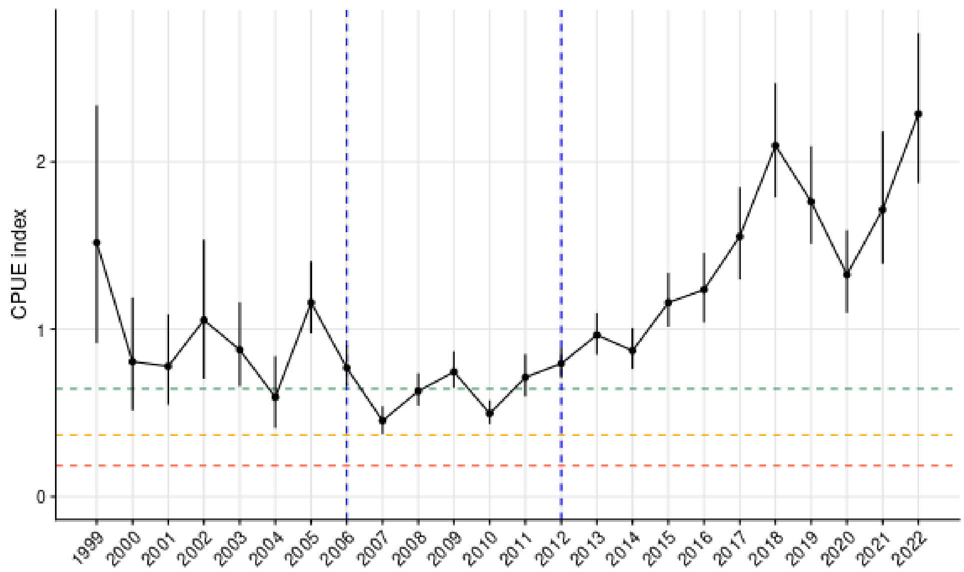
| **Fishery Interactions** |
|---|
| JMA 7 catches are primarily taken by midwater trawl. Availability of ACE for kingfish and snapper potentially influences targeting in some sub-areas. Incidental captures of protected species have been recorded for New Zealand fur seals and cetaceans. |

- **JMA 7 -** *T. novaezealandiae*

| **Stock Status** | | |
|---|---|---|
| Most Recent Assessment Plenary Publication Year | 2023 | |
| Catch in most recent year of assessment | Year: 2021–22 | Catch: - |
| Assessment Runs Presented | Event resolution CPUE index from observer data from jack mackerel target midwater trawls with length frequency sampling (JMN7 MW observer) | |

| | |
|---|---|
| Reference Points | Management Target: the geometric mean CPUE for the period 2006–2012 (a conceptual proxy for $B_{MSY}$)<br>Soft Limit: 20% $B_0$; scaled from management target<br>Hard Limit: 10% $B_0$; scaled from management target<br>Overfishing threshold: not established |
| Status in relation to Target | Very Likely (> 90%) to be at or above the target |
| Status in relation to Limits | Very Unlikely (< 10%) to be be below both the soft and hard limits |
| Status in relation to Overfishing | Unknown |

**Historical Stock Status Trajectory and Current Status**




**Combined (binomial/positive catch) standardised catch per unit effort (CPUE) index for *T. novaezealandiae* in JMA 7 (calculated from observer data using the subset of tows where length frequency sampling permits estimation of catch by species) relative to the agreed reference points.**

| **Fishery and Stock Trends** | |
|---|---|
| Recent Trend in Biomass or Proxy | CPUE increased from 2010 to 2018 and has fluctuated without trend to 2022 |
| Recent Trend in Fishing Intensity or Proxy | Unknown |
| Other Abundance Indices | - |
| Trends in Other Relevant Indicators or Variables | - |

| **Projections and Prognosis** | |
|---|---|
| Stock Projections or Prognosis | Unknown |
| Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits | Current catch<br>Soft Limit: Unlikely (< 40%) in the short term<br>Hard Limit: Unlikely (< 40%) in the short term |
| Probability of Current Catch or TACC causing Overfishing to continue or to commence | Unknown |

| **Assessment Methodology and Evaluation** | | |
|---|---|---|
| Assessment Type | Level 2 – Partial quantitative stock assessment | |
| Assessment Method | CPUE analysis | |
| Assessment Dates | Latest assessment Plenary publication year: 2023 | Next assessment: 2025 |
| Overall assessment quality rank | 1 – High quality | |

| | | |
|---|---|---|
| Main data inputs (rank) | - Observer catch records and length frequency samples | 1 – High Quality |
| Data not used (rank) | - Catch at age | 2 – Medium or Mixed Quality: the methods used for producing scaled catch at age distributions require re-evaluation |
| Changes to Model Structure and Assumptions | - Species-specific CPUE has replaced a combined species analysis | |
| Major Sources of Uncertainty | - | |

| **Qualifying Comments** |
|---|
| - |

| **Fishery Interactions** |
|---|
| JMA 7 catches are primarily taken by midwater trawl. Availability of ACE for kingfish and snapper potentially influences targeting in some sub-areas. Incidental captures of protected species have been recorded for New Zealand fur seals and cetaceans. |

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