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Stock assessment of western tarakihi for 2026

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PLAIN LANGUAGE SUMMARY

There are two biological stocks of tarakihi around mainland New Zealand, one off the east coast and one off the west coast. This report presents the first assessment for the western stock of tarakihi, which includes TAR 8 and the western portions of TAR 1 and TAR 7. The adult population is estimated to have declined to the default target biomass level (40% SB_0) by 2010. Stock biomass is estimated to have declined over the last 10–15 years (to 2024–25) and is predicted to continue to decline due, in part, to a period of low recruitment in recent years (2016–2022).

EXECUTIVE SUMMARY

Langley, A.D. (2026). Stock assessment of western tarakihi for 2026.

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Tarakihi (*Nemadactylus macropterus*) are distributed throughout the coastal waters around the North Island and South Island. There are two separate stocks of tarakihi within this area: an eastern stock encompassing Quota Management Areas (QMAs) TAR 3, TAR 2 and the eastern portions of TAR 1 and TAR 7 and a western stock including TAR 8 and the western portions of TAR 1 and TAR 7. The stock units are discriminated based on differential trends in abundance indices (CPUE and trawl surveys), persistent differences in the age structure (year class strengths) and differences in growth rates.

The tarakihi catch is predominantly taken by the inshore trawl fleet. For the western stock three main fishery areas are defined: west coast North Island (WCNI) (western TAR 1), TAR 8 and west coast South Island (WCSI) (western TAR 7). Annual catches from the WCNI and WCSI fisheries have declined over the last 10 years, while CPUE indices derived for the two fisheries have also declined. There has also been a corresponding decline in the abundance of tarakihi biomass indices from the *Kaharoa* WCSI inshore trawl surveys during the same period. The recent trawl surveys also indicate that juvenile tarakihi (1 y and 2 y old) abundance has been low.

Recent catch sampling programmes have provided age compositions for the main western tarakihi fisheries, augmenting the time series of age compositions from the WCSI trawl survey programme and *Kaharoa* WCNI trawl surveys.

The availability of these data enabled the development of the first stock assessment for western tarakihi. The assessment estimated that the stock declined to the default target biomass level (40% SB_0) by 2010. The magnitude of the decline is strongly informed by the age composition data from the WCSI trawl survey and, more recently, the main commercial fisheries. Trends in abundance over the last 25–30 years are mediated by the biomass indices from the trawl surveys and the CPUE indices from the WCNI fishery.

Stock biomass is estimated to have declined over the last 10–15 years (to 2024–25) and is predicted to continue to decline due, in part, to a period of low recruitment in recent years (2016–2022).

The recent (2016–2022) low recruitments have corresponded to a period of warmer sea temperatures off western New Zealand. Further work is required to investigate the relationship between tarakihi recruitment and prevailing oceanographic conditions. It is unknown whether the recent low recruitments are simply a transient process or represent a longer-term shift in the overall productivity of the stock. Ongoing monitoring of recruitment will be important for monitoring the western tarakihi stock over the medium term (5–10 years).

1. INTRODUCTION

Tarakihi (*Nemadactylus macropterus*) supports important inshore fisheries around the New Zealand coast. In the 2024–25 fishing year, the tarakihi (TAR) fisheries around the northern North Island (TAR 1 Total Allowable Commercial Catch (TACC) 978 t), off the central east coast of the North Island (TAR 2 TACC 1104 t), off the east coast of the South Island (TAR 3 TACC 694 t), in Southland (TAR 5 TACC 153 t), off the west coast of the South Island and Cook Strait (TAR 7 TACC 994 t), and lower west coast of the North Island (TAR 8 TACC 225 t) yielded a cumulative commercial catch of 3574 t of tarakihi (Fisheries New Zealand 2025).

The stock structure of tarakihi around mainland New Zealand was reviewed by Langley & Starr (2012) and Langley (2018, 2022). Trends in fishery CPUE indices and age compositions from commercial catches and trawl surveys suggest that tarakihi along the east coasts of the North and South Islands represent a single biological stock. Sampling of the age compositions of the tarakihi catches from the main fisheries around coastal New Zealand identified persistent differences in the age structure between the fisheries in the eastern and western areas (McKenzie et al. 2017, 2021, 2026). Tagging studies indicate that there is a considerable northward movement of fish from the east coast of the South Island to the Wairarapa coast, East Cape, and the Bay of Plenty (Annala 1988). These results support the current stock hypothesis that eastern tarakihi represents a separate stock unit, while providing evidence of a separate western tarakihi stock unit. Nonetheless, a small number of tagged fish released off Kaikoura were recovered from the west coast North Island (Annala 1988), suggesting some degree of connectivity between the eastern and western areas.

A stock assessment for eastern tarakihi, encompassing TAR 3, TAR 2, and the eastern portions of TAR 1 and TAR 7 was conducted in 2018 and updated in 2019, 2020, 2021 and 2026 (Langley 2018, 2019, 2022, in prep.). The eastern tarakihi stock assessment incorporated the annual catches, age composition data, and CPUE and trawl survey indices from the constituent fisheries. For western tarakihi, a stock assessment was conducted for the west coast South Island portion of TAR7 in 2008 (Manning unpublished). However, no assessment has been conducted for the entire western tarakihi stock.

Previous studies have characterised the main western tarakihi fisheries using catch and fishing effort data from the commercial fishing fleet (Langley 2021, McKenzie et al. 2021). The tarakihi catch is predominantly taken by the inshore trawl fleet. The previous studies partitioned western tarakihi into three main fishery areas: west coast North Island (WCNI) (western TAR 1), TAR 8 and west coast South Island (WCSI) (western TAR 7) (Figure 1). These areas are geographically distinct and the operation of the tarakihi fisheries differ amongst the three areas. There are also differences in the age composition of the catches from the three areas (McKenzie et al. 2021). The previous studies derived standardized CPUE indices for each of the main tarakihi fisheries within TAR 1, TAR 7, and TAR 8 (Langley 2021).

For western TAR 7, tarakihi abundance has been monitored by the time series of *Kaharoa* west coast South Island inshore trawl surveys (Stevenson & Hanchet 2000, MacGibbon & Stevenson 2013, Stevenson & MacGibbon 2015, 2018, MacGibbon 2019, MacGibbon et al. 2022, 2024). Age compositions for tarakihi are available from most of the WCSI trawl surveys. A more limited series of inshore trawl surveys has also been conducted off the west coast of the North Island (Jones et al. 2022, 2024), with associated age compositions available for tarakihi.

The current study updated the previous characterisations of the western TAR 1, TAR 8, and western TAR 7 fisheries, including catch and effort data from the 1989–90 to 2024–25 fishing years. The CPUE analyses for western TAR 1, TAR 8 and western TAR 7 trawl fisheries were also updated to the 2024–25 fishing year.

The compilation of data from the inshore trawl survey programmes and the three main commercial fisheries enabled the development of a stock assessment for western tarakihi. The assessment was funded by Fisheries New Zealand under Research Contract TAR2024-01 entitled “West coast tarakihi stock assessment”.

2. COMMERCIAL FISHERY CHARACTERISATION

2.1 Fishery structure

Previous characterisations of the tarakihi fisheries around the South Island and North Island have defined the main fisheries by fishing method and Statistical Area (e.g. McKenzie et al. 2017, McKenzie et al. 2021). Where appropriate, the fishery definitions also maintain the approximate demarcation of the individual tarakihi Quota Management Areas (QMAs). The fishery definitions were adopted by the recent catch sampling programmes and, hence, represent the basic level of resolution for the age composition data (McKenzie et al. 2017, McKenzie et al. 2021, McKenzie et al. 2026).

For the western stock unit, three main fishery areas have been identified: WCNI (western portion of TAR 1), TAR 8 and WCSI (western portion of TAR 7) (Figure 1). In addition, tarakihi represent a small catch within Tasman Bay/Golden Bay (TAR 7). The eastern portion of TAR 7 is included within a fishery encompassing the eastern Cook Strait and has been included in the eastern tarakihi stock assessment.

Previously, trends in catch and effort from the western tarakihi fisheries (TAR 1W, TAR 8 and TAR 7W) were described in Langley 2021. This section updates the previous analyses, incorporating data up to the 2024–25 fishing year.

2.2 Dataset

The western fishery areas were defined based on Statistical Areas (Table 1) to enable the catches from the entire period from which catch and effort data were available to be apportioned appropriately. Since 2007–08, all trawl catch and effort data have been collected by fishing location, enabling a more accurate assignment of catches between fishery areas. The Statistical Area boundaries only provide an approximation of the Quota Management Areas (Figure 1). In particular, Statistical Area 037 straddles the boundary between TAR 7 and TAR 8, while Statistical Area 041 straddles the boundary between TAR 8 and TAR 1. An examination of the location of the tarakihi catches within Statistical Area 037 revealed that most of the catch was taken within TAR 7. Similarly, most of the tarakihi catch from 041 was taken within TAR 8.

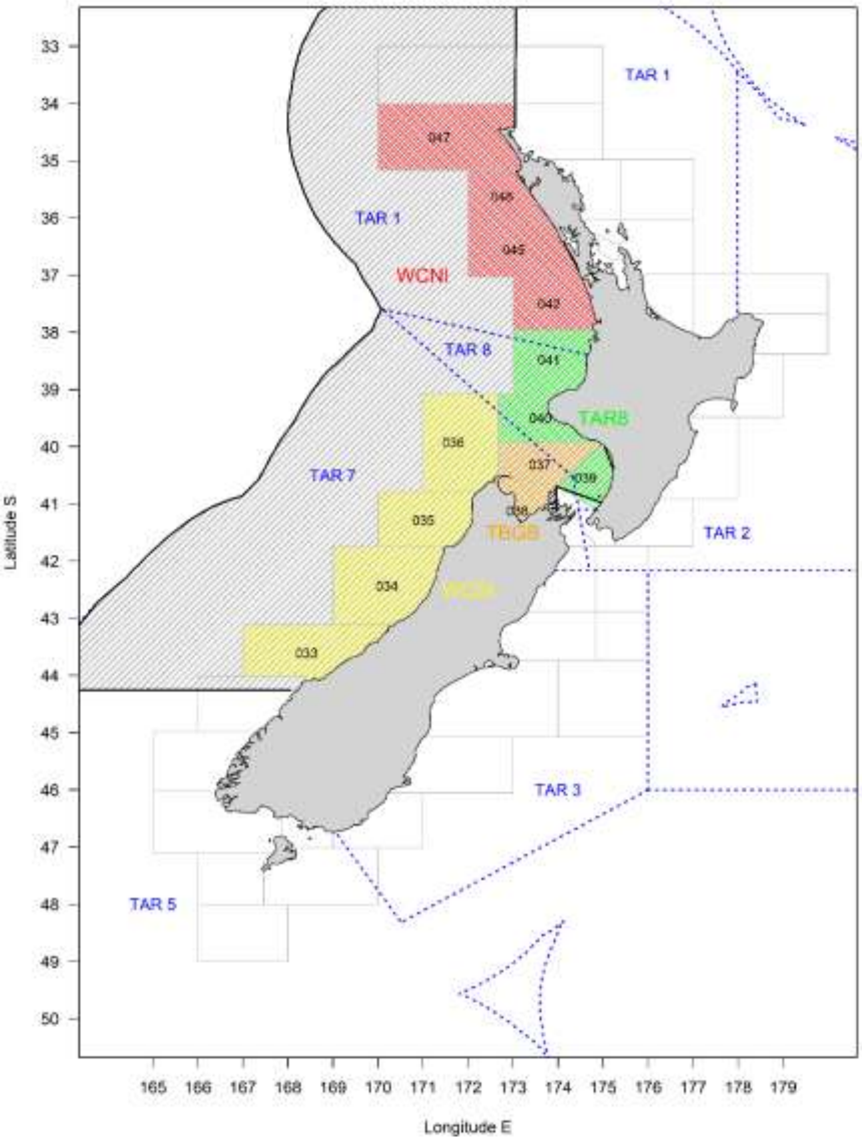

Figure 1: Map of the domain of the western tarakihi stock assessment and constituent Statistical Areas.

Table 1: Fishery Statistical Area used to define the commercial tarakihi fisheries.

Fishery	QMA	Statistical Areas
West Coast North Island WCNI	TAR 1 (W)	042, 045, 046, 047
Central TAR 8	TAR 8	039, 040, 041, 801
Tasman Bay and Golden Bay TBGB	TAR 7 (W)	037, 038
West Coast South Island WCSI	TAR 7 (W)	033-036

Commercial catch and effort data from the tarakihi fishery were sourced from the Fisheries New Zealand EDW database. Initially, a complete set of tarakihi catch and effort data was obtained for the tarakihi QMAs around mainland New Zealand: TAR 1 TAR 2, TAR 3, TAR 5, TAR 7, and TAR 8 QMAs. The wider scope of the data extract was to enable an appraisal of the tarakihi across QMAs and defined fishery boundaries.

The data extract included the catch and effort data from any fishing trip that recorded a catch of tarakihi from the QMAs. The extract was supplemented by data from any additional fishing trips that conducted fishing within the statistical areas that comprise the inshore area around mainland New

Zealand (Statistical Areas 001–048) and targeted the range of inshore species (tarakihi, TAR; snapper *Chrysophrys auratus*, SNA; trevally *Pseudocaranx dentex*, TRE; red cod *Pseudophycis bachus*, RCO; barracouta *Thyrsites atun*, BAR; gemfish *Rexea solandri*, SKI; blue warehou *Seriolella brama*, WAR; red gurnard *Chelidonichthys kumu*, GUR; ghost shark, GSH; giant stargazer, STA; and John dory *Zeus faber*, JDO) that are caught in association with tarakihi.

For the qualifying trips, all effort data records were sourced, regardless of whether tarakihi was landed. The estimated catches and landed catch records of all finfish species were also sourced for the qualifying fishing trips. Data were complete to the end of the 2024–25 fishing year.

From 1989–90, most inshore fishing vessels reported catch and effort data via the Catch Effort Landing Return (CELR), which records aggregated fishing effort and the estimated catch of the top five species. Fishing effort and catch was required to be recorded for each target species and statistical area fished during each day, although typically catch and effort data were aggregated by fishing day (Langley 2014). The verified landed greenweight that is obtained at the end of the trip was recorded on the Landings section of the CELR form.

From 1994–95, many of the inshore trawlers operating in TAR 1 reported fishing effort and catch data for individual trawls/tows via the Trawl Catch Effort and Processing Return (TCEPR). In 2007–08, the Trawl Catch and Effort Return (TCER) was introduced specifically for the inshore trawl fisheries and was adopted by most of the inshore trawl vessels within the tarakihi fishery. The TCEPR and TCER forms recorded detailed fishing activity, including trawl start location and depth, and associated (estimated) catches from individual trawls. Landed catches associated with trips reported on TCEPR and TCER forms were reported at the end of a trip on the Catch Landing Return (CLR).

From mid-2019, Electronic Reporting Systems (ERS) were introduced for the main inshore trawl fleet and most other fishing methods, following the initial introduction on vessels operating in deepwater fisheries. The ERS record positional data for fishing events and store and transmit the associated fishing event and catch data for statutory reporting. The ER system is based around the seven reporting components: Trip Start, Fish Catch, Non Fish Protected Species (NFPS) Catch, Processing, Disposal, Landing, and Trip End. Fish Catch reports record the details of the fishing activity and the estimated species catch. Trawl vessels under 28 m are required to report the catch of the top 8 (Quota Management System (QMS and non QMS) species caught from each trawl, although typically catches have been recorded for a larger number of species.

The initial set of tarakihi landed-catch records was screened to retain the records that represented the final destination of the tarakihi catch (destination codes L, LR, EOY, A, C, E, and O). Almost all (99.7%) of the landed catch was attributed to destination code L (i.e., conveyed to an LFR at the time of landing).

The catch and effort data sets were processed following the methodology described by Langley 2014. Two data sets were configured:

1) **Daily** aggregated catch and effort data set from 1989–90 to 2024–25. Tarakihi catch and effort data were aggregated by vessel fishing day and fishing method to approximate the CELR data format. The predominant statistical area and target species recorded during the fishing day were assigned to the Daily aggregate record. For each trip, the landed catch of tarakihi was apportioned amongst the daily fishing records in proportion to the estimated catches of tarakihi (when included within the five main species caught in the day). Tarakihi landed catches from trips without corresponding estimated catches were distributed amongst daily records in proportion to fishing effort (number of trawls).
2) **Trawl** based catch and effort data set from 1994–95 to 2024–25. TCEPR, TCER, and ERS format catch and effort records. For each trip, the landed catch of tarakihi was apportioned amongst the individual trawl records in proportion to the estimated catches of tarakihi (when recorded in the five main species caught in the trawl). Tarakihi landed catches from trips without corresponding estimated catches were distributed equally amongst trawl records.

For the daily data set, almost all (98%) of the landed catch of tarakihi was allocated to fishing days with associated estimated catches. The remainder of the landed catch was allocated equally amongst the associated fishing events, representing a significant proportion of the overall fishing days (29%) assigned small quantities of tarakihi catch (about 2–3 kg).

Total annual catches of tarakihi under the Quota Management System (QMS) are compiled from Monthly Harvest Returns (MHR) submitted by fishing permit holders. Overall, the annual landed catches for TAR 1, 2, 3, 5, 7, and 8 included in the characterisation data set approximated the corresponding Fishstock catches reported by Fisheries New Zealand (Fisheries New Zealand 2025) (Figure 2).

Estimated catches were assigned to QMAs based on Statistical Area definitions. Due to the differences in the boundaries between QMAs and Statistical Areas, there are some discrepancies between annual estimated catches and MHR catches for individual QMAs. Specifically, for TAR 8, estimated tarakihi catches exceeded the MHR landed catches in some years (Figure 2). This is attributable to the mis- attribution of all the tarakihi catch from Statistical Area 041 to TAR 8, rather than dividing the catch from Statistical Area 041 between TAR 8 and the western portion of TAR 1.

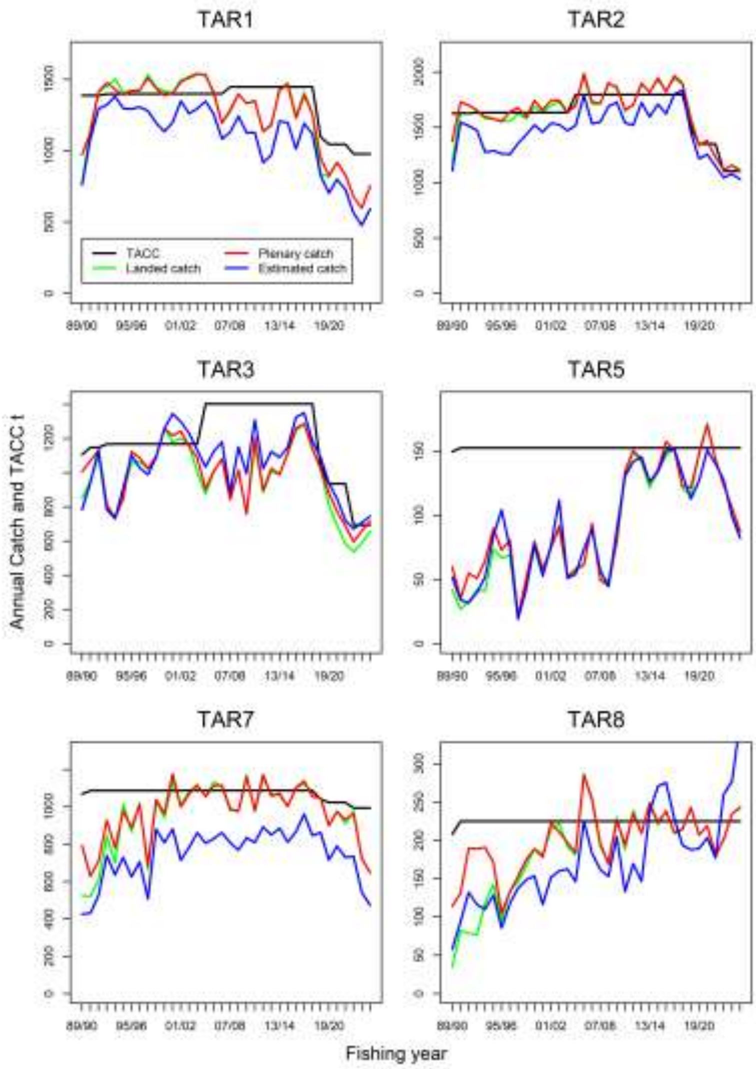

Figure 2: Annual tarakihi reported catches (Plenary catch) and Total Allowable Commercial Catch (TACCs) by Quota Management Area and the landed and estimated catches included in the catch and effort data set.

2.3 Recent trends

Tarakihi catches are taken throughout the coastal areas around the North Island and South Island, predominantly shallower than about 200 m (Figure 3 and Figure 4). For the western areas, tarakihi catches are highest off the west coast of the South Island (TAR 7W) and off Ninety Mile Beach (TAR 1W). Catches from TAR 8 are taken off the Kapiti coast and in deeper water off Cape Egmont (Figure 3 and Figure 4).

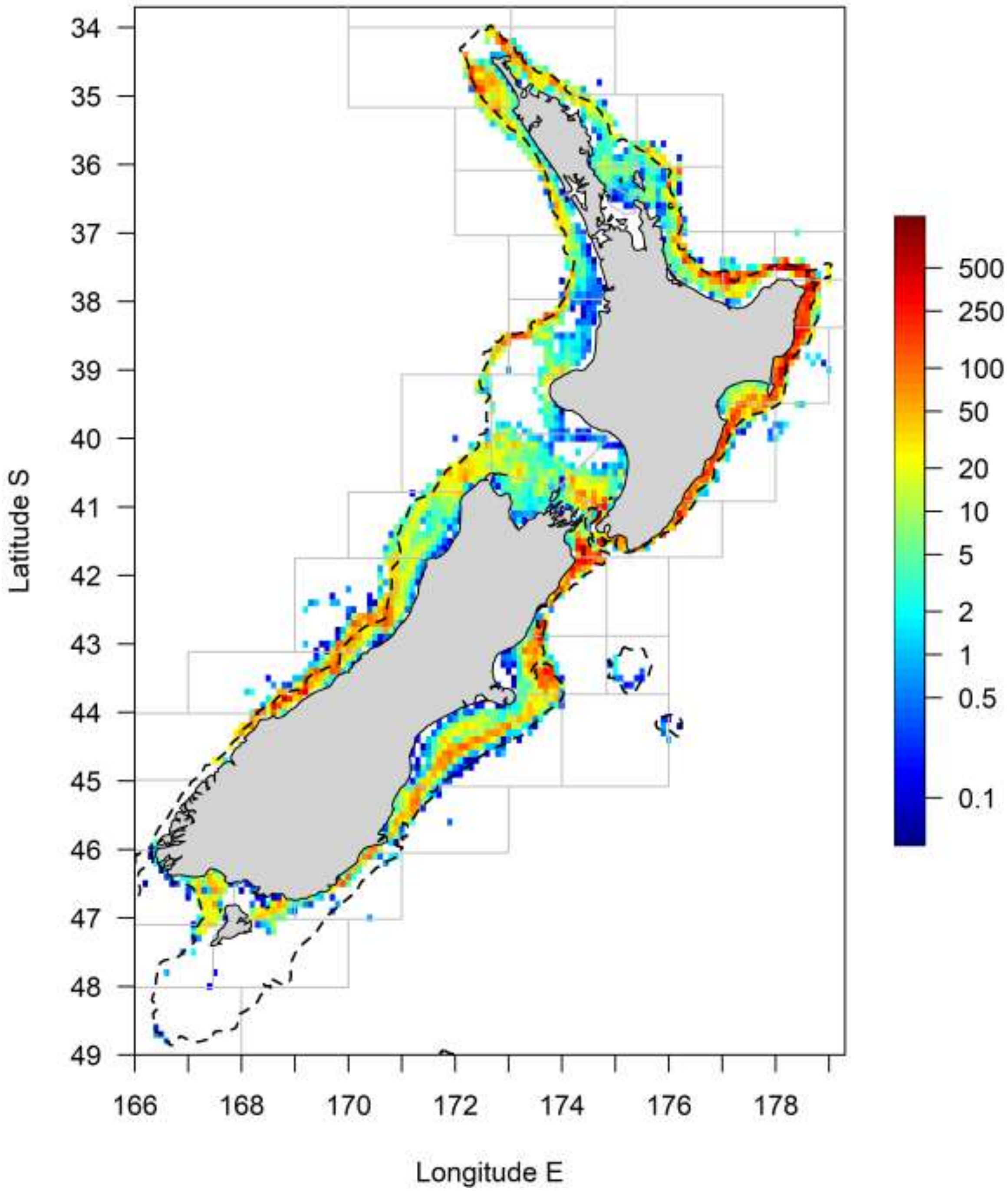

Figure 3: Distribution of the total tarakihi catch (t) from BT and PRB by 0.1 degree latitude and longitude (log scale) from 2007–08 to 2024–25. The black dashed line represents the 200 m depth contour. Each cell includes data from a minimum of three permit holders.

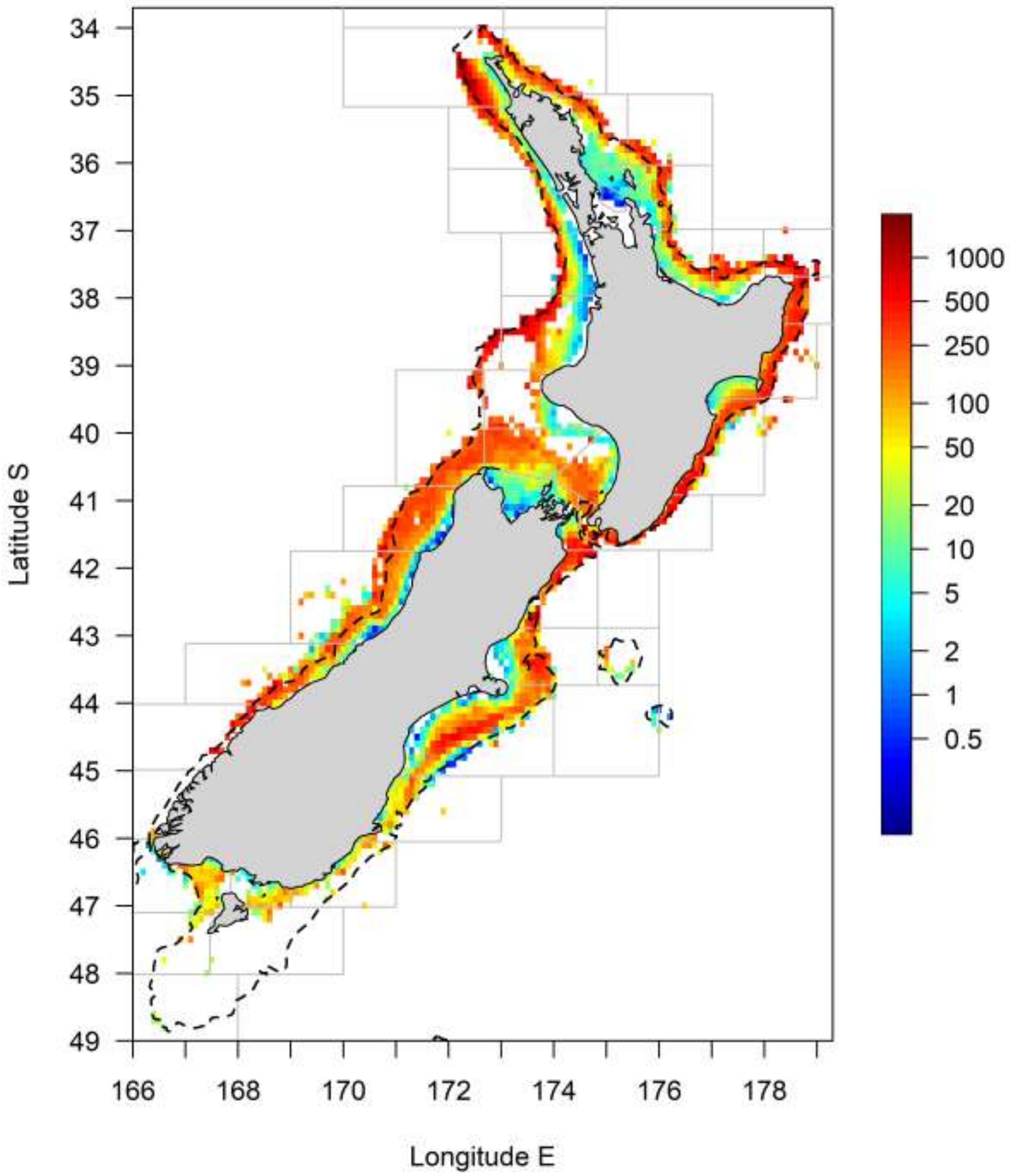

Figure 4: Average tarakihi catch per trawl (kg) from BT and PRB by 0.1 degree latitude and longitude (log scale) from 2007–08 to 2024–25. The black dashed line represents the 200 m depth contour. Each cell includes data from a minimum of three permit holders.

Annual catches of tarakihi from the western area have been dominated by the WCSI fishery and, to a lesser extent, the WCNI fishery (Figure 5 and Figure 6). Catches from these two fisheries increased during the 1990s and early 2000s and then remained relatively stable until 2020–21. Over the subsequent years, catches from both fisheries decreased considerably. Most of the reduction in catch from the WCNI fishery has occurred in the northern area of the fishery (Statistical Area 047) (Figure 6).

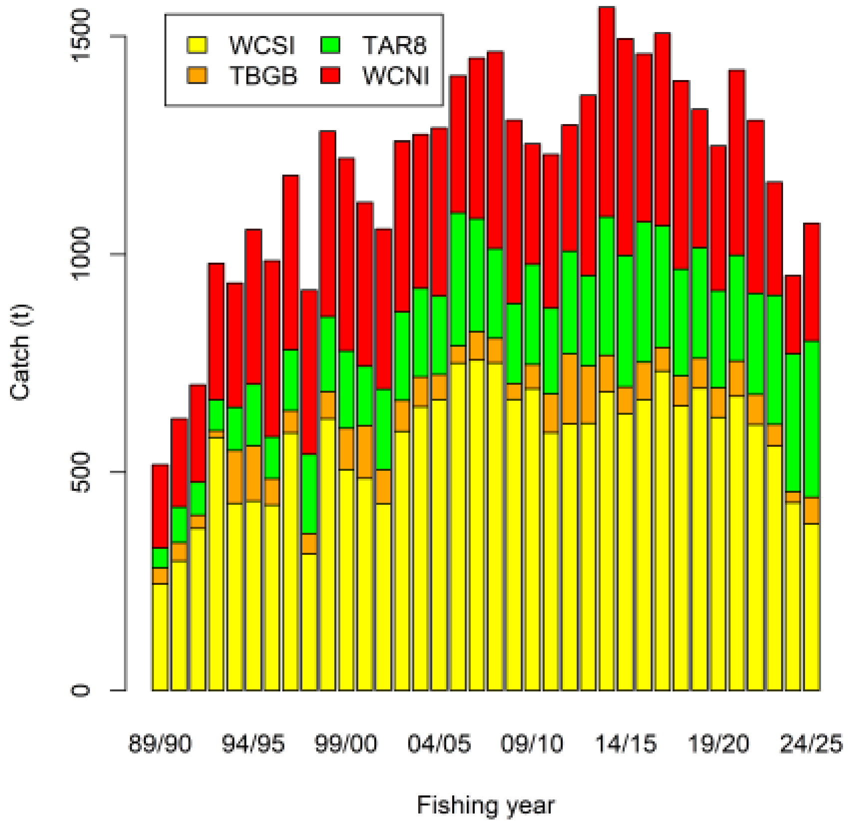

Figure 5: Distribution of annual western tarakihi catches by fishery area.

For TAR 8, annual catches generally increased over the study period and accounted for an increasing proportion of the western tarakihi catch, especially in the last few years (Figure 5 and Figure 6).

The TBGB fishery accounts for a relatively small proportion of the overall catch (typically less than 6%). Most of the TBGB catch was from the outer area (Statistical Area 037) with minor catches taken from Statistical Area 038 (Figure 5 and Figure 6).

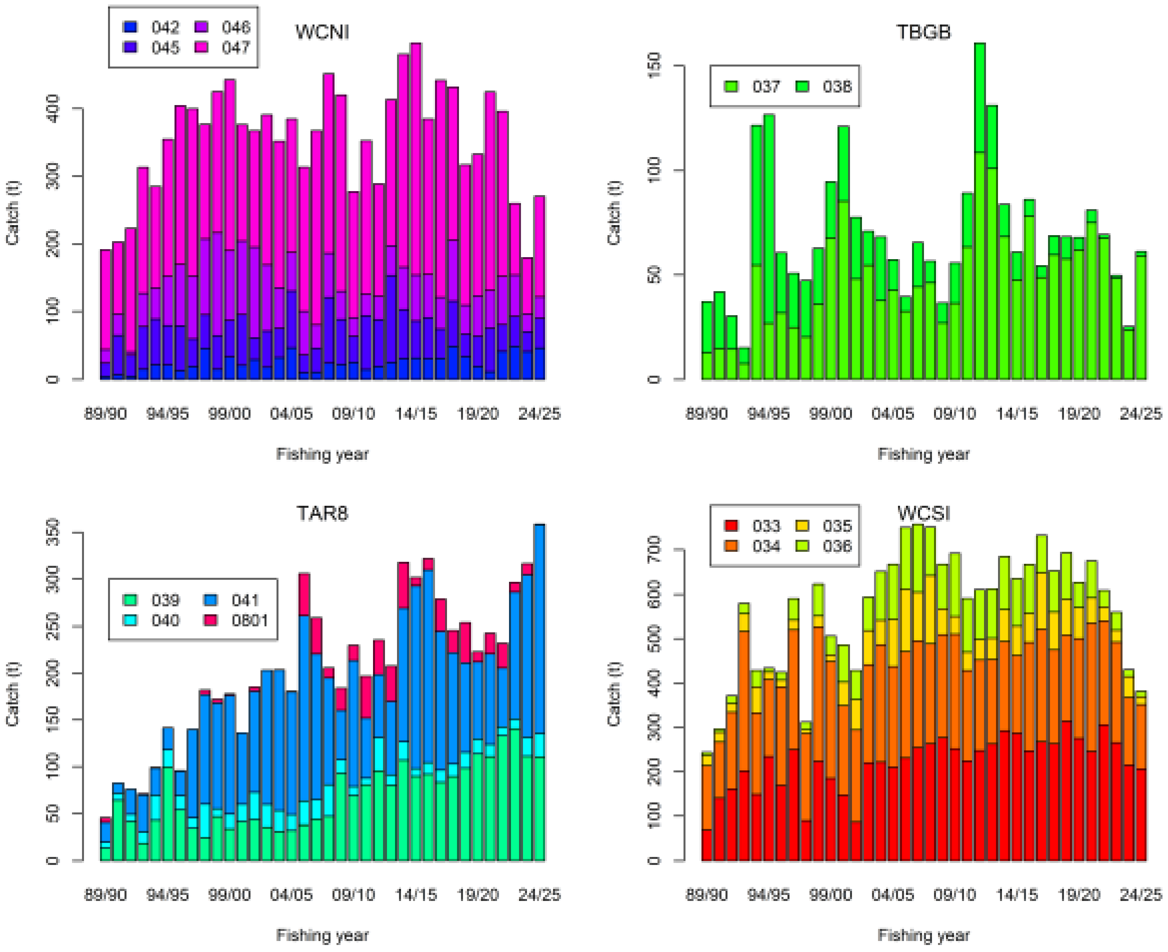

Figure 6: Distribution of annual tarakihi catches by Statistical Area for each fishery area.

WCNI

Most (86%) of the catch from the WCNI tarakihi fishery was taken by the single bottom trawl method with most of the remainder taken by Precision trawl gear (PRB) in recent years (Figure 7). The single trawl catch was predominantly taken by the target fishery and as a bycatch of trawls targeting trevally, snapper, and red gurnard (Figure 7). The catch from the target fishery peaked during the 2010s and then declined during 2021–22 to 2023–24. There was an increase in the target PRB catch in 2024–25.

The tarakihi catch from the trawl fishery was taken throughout the WCNI fishery area between Cape Reinga and Cape Egmont (Figure 3), although the catch was concentrated in the area off Ninety Mile Beach (Statistical Area 047) in the 100–200 m depth range. Catches in that area declined in recent years (Figure 6).

Most of the WCNI tarakihi catch was taken during February–May although in some years considerable catches were taken outside that period (Figure 8).

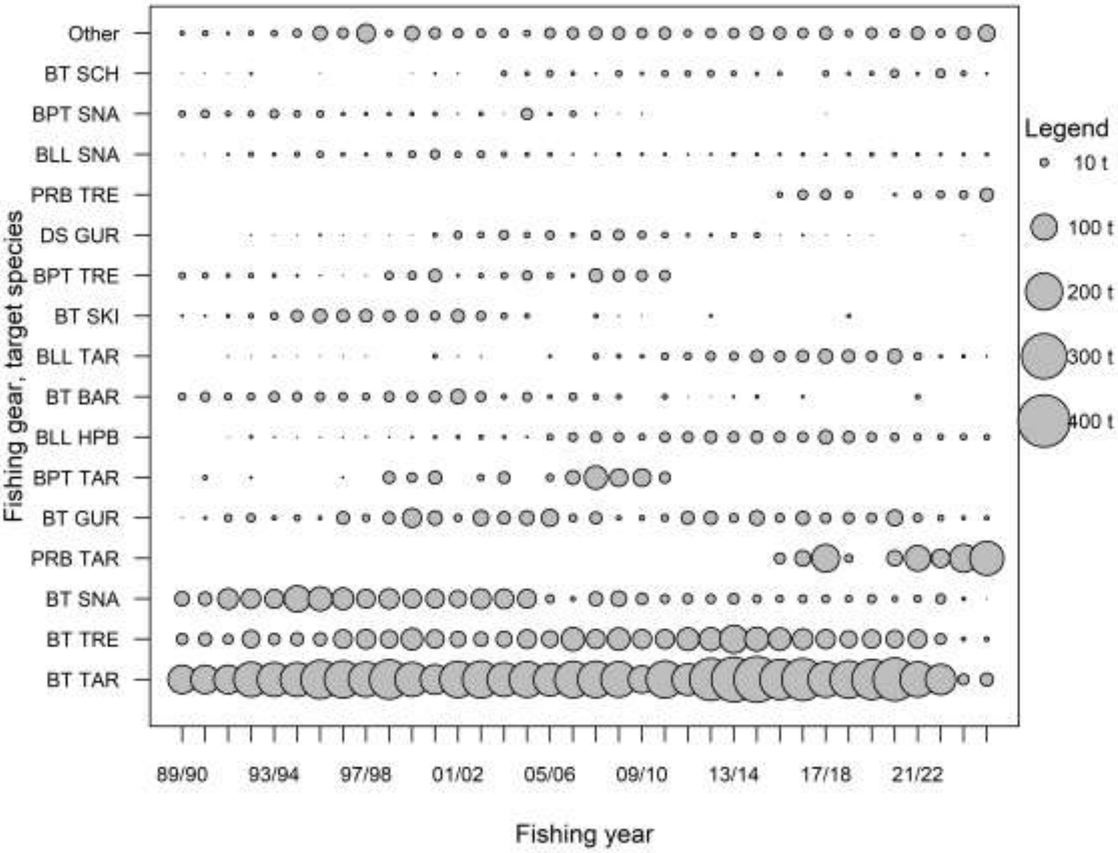

Figure 7: Annual tarakihi catch from the WCNI (TAR 1) fishery by fishing gear (BT, bottom single trawl; BPT, bottom pair trawl; BLL, bottom longline; PRB, Precision Harvesting bottom trawl gear; DS, Danish seine) and declared target species (SNA, snapper; TRE, trevally; GUR, red gurnard; TAR, tarakihi; BAR, barracouta; JDO, John dory; SCH, school shark; hapuku, HPB; gemfish, SKI). The area of the circle is proportional to the catch.

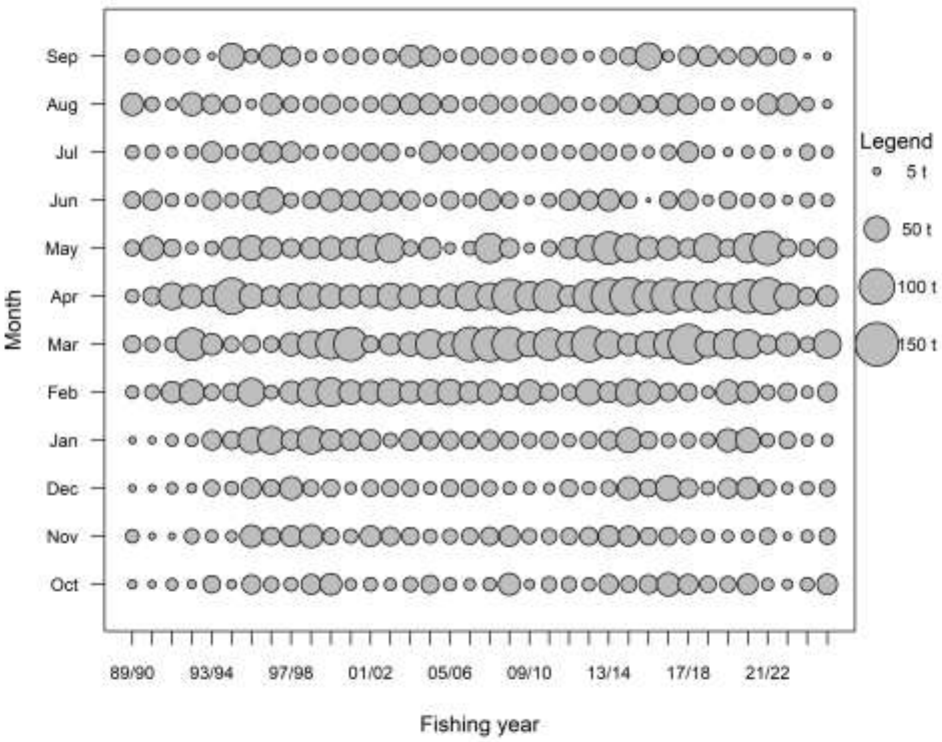

Figure 8: Annual tarakihi catch from the WCNI (TAR 1) fishery by month. The area of the circle is proportional to the catch.

TAR 8

The total catch from TAR 8 increased during the 1990s and remained at about the level of the TACC (225 t) from 1998–99 (Figure 2). Since then, most (about 70%) of the annual TAR 8 catch was taken by the target trawl fishery, with an increase in the PRB trawl gear in 2023–24 and 2024–25 (Figure 9). The remainder of the catch was taken as a bycatch of other inshore trawl fisheries, in particular red gurnard, school shark and John dory.

The TAR 8 catch was predominantly taken from the North Taranaki Bight (Statistical Area 041), extending westwards along the shelf edge off Cape Egmont (Statistical Area 801), and off the Kapiti coast (039) (Figure 10). Limited catch was taken from the South Taranaki Bight (040) (Figure 3) and, on that basis, catches from Statistical Area 037 which straddles the boundary of TAR 8 and TAR 7 were assigned to the TBGB (TAR 7) fishery.

The magnitude of the tarakihi catch from Statistical Area 041 fluctuated over the last 25 years with larger catches taken during 2002–03 to 2006–07, 2013–14 to 2016–17 and 2022–23 to 2024–25 (Figure 10). There was a general increase in the tarakihi catch from Statistical Area 039 from 2003–04 to 2022–23.

There is no strong seasonal pattern in the distribution of the TAR 8 catch, although in some years a considerable proportion of the catch was taken during March–May (Figure 11). The target trawl fishery predominantly operates during this period.

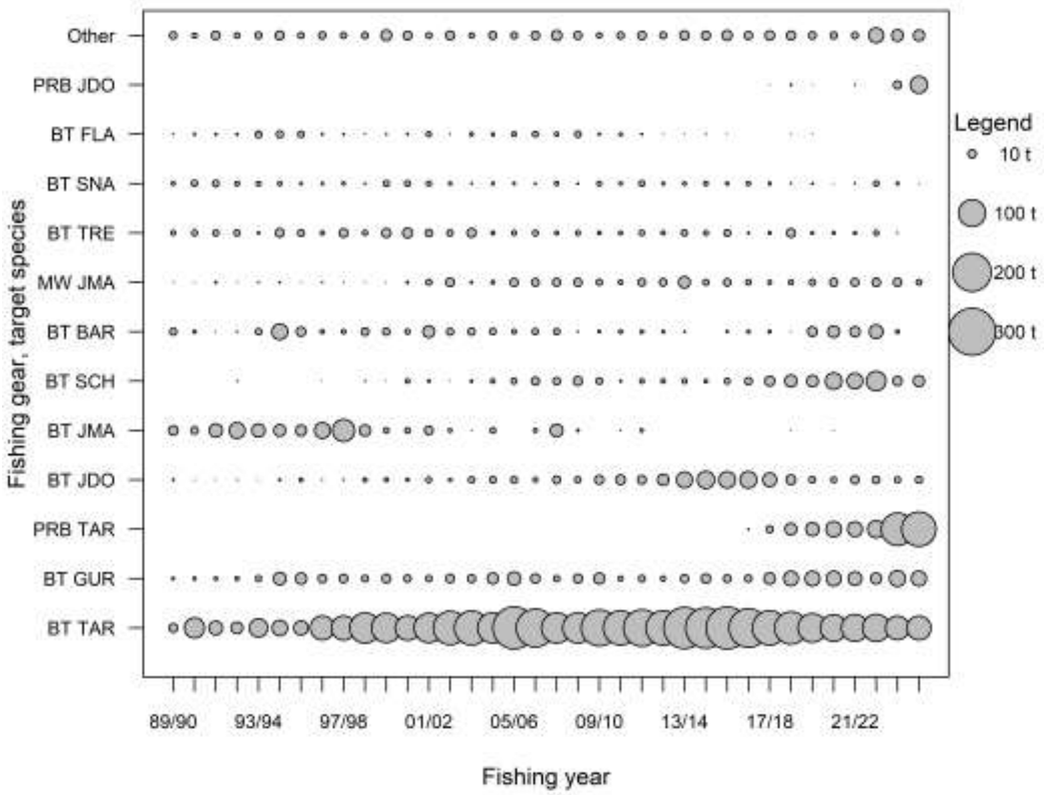

Figure 9: Annual tarakihi catch from the TAR 8 fishery by fishing gear (BT, bottom single trawl; MW, mid-water trawl; PRB, Precision Harvesting bottom trawl gear) and declared target species (SNA, snapper; TRE, trevally; GUR, red gurnard; TAR, tarakihi; JMA, jack mackerel; BAR, barracouta; JDO, John dory; SCH, school shark; FLA, flatfish species). The area of the circle is proportional to the catch.

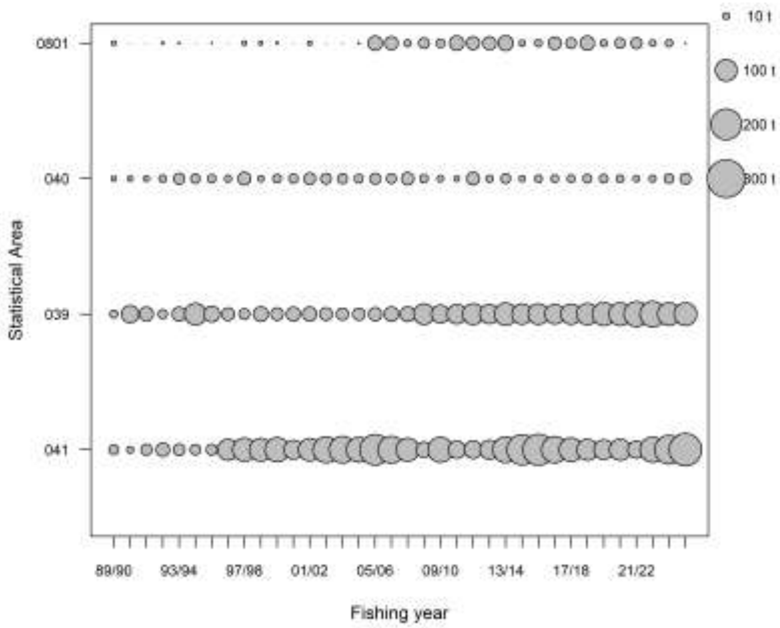

Figure 10: Annual tarakihi catch from the TAR 8 fishery by Statistical Area. The area of the circle is proportional to the catch.

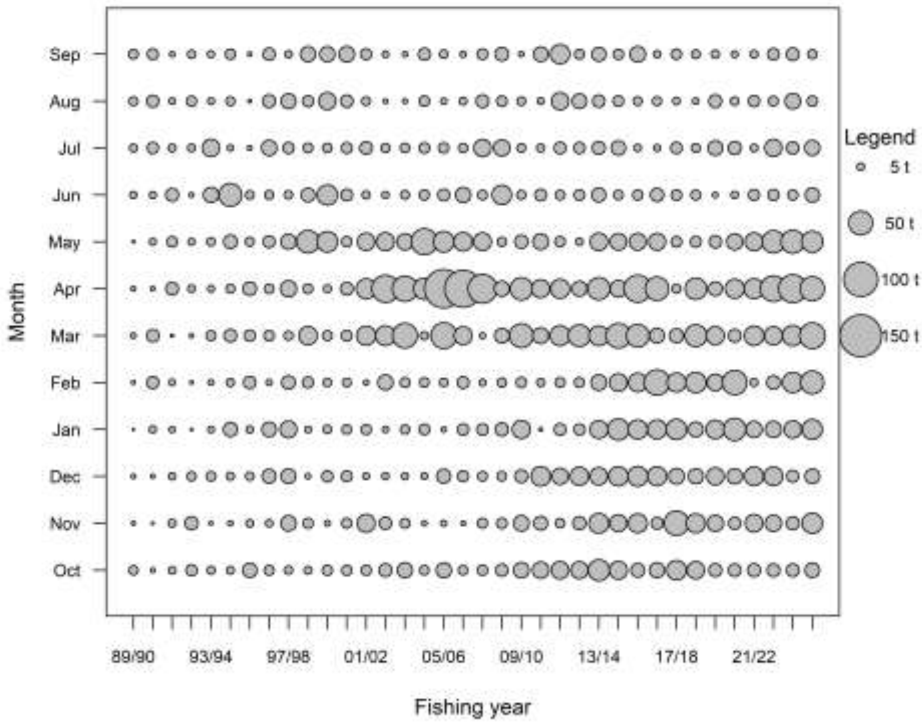

Figure 11: Annual tarakihi catch from the TAR 8 fishery by month. The area of the circle is proportional to the catch.

TBGB

Overall, annual catches from the TBGB fishery were relatively small and since 1997–98 were dominated by catches from Statistical Area 037 (Figure 6). Tarakihi was caught from a range of bottom trawl fisheries, including a target fishery that accounted for a substantial proportion of the catch during the 2010s (Figure 12). The catches were predominantly taken during September-December (Figure 13).

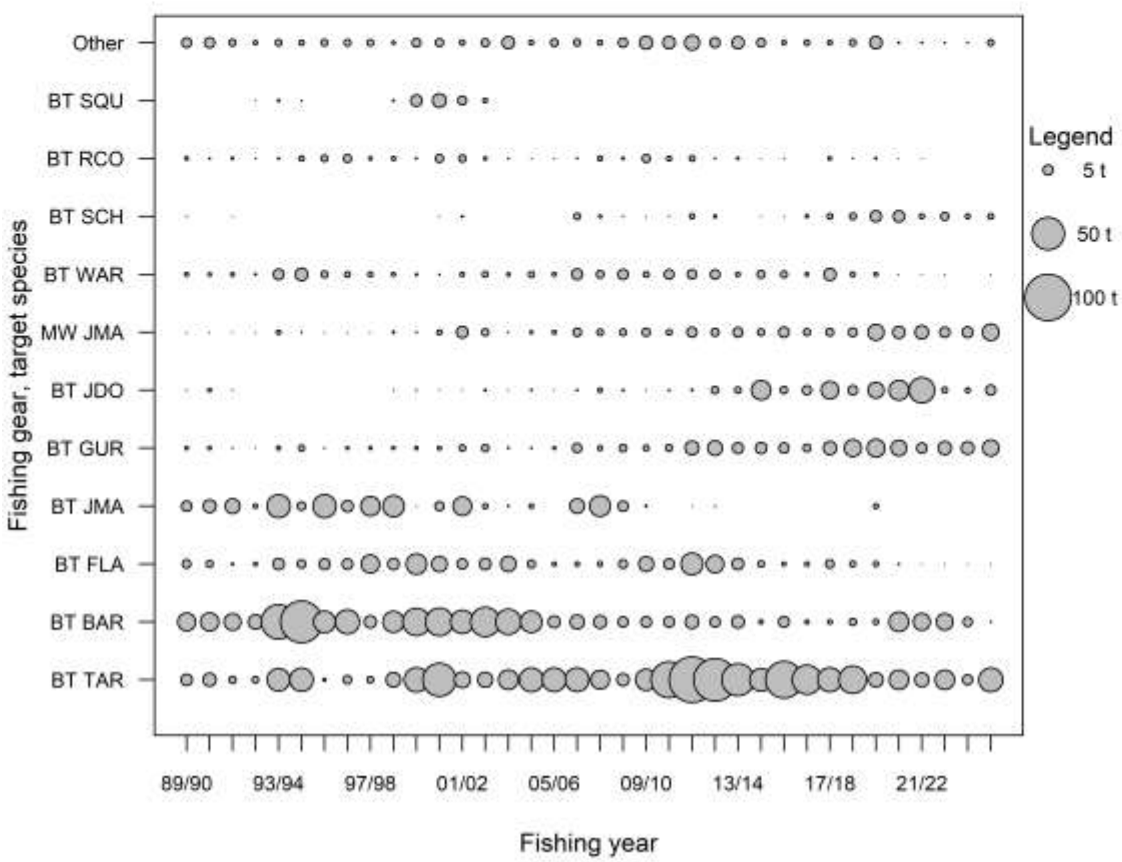

Figure 12: Annual tarakihi catch from the TBGB (TAR 7) fishery by fishing gear (BT, bottom single trawl; MW, mid-water trawl) and declared target species (GUR, red gurnard; TAR, tarakihi; JMA, jack mackerel; BAR, barracouta; JDO, John dory; SCH, school shark; FLA, flatfish species; WAR, blue warehou; RCO, red cod; SQU, arrow squid). The area of the circle is proportional to the catch.

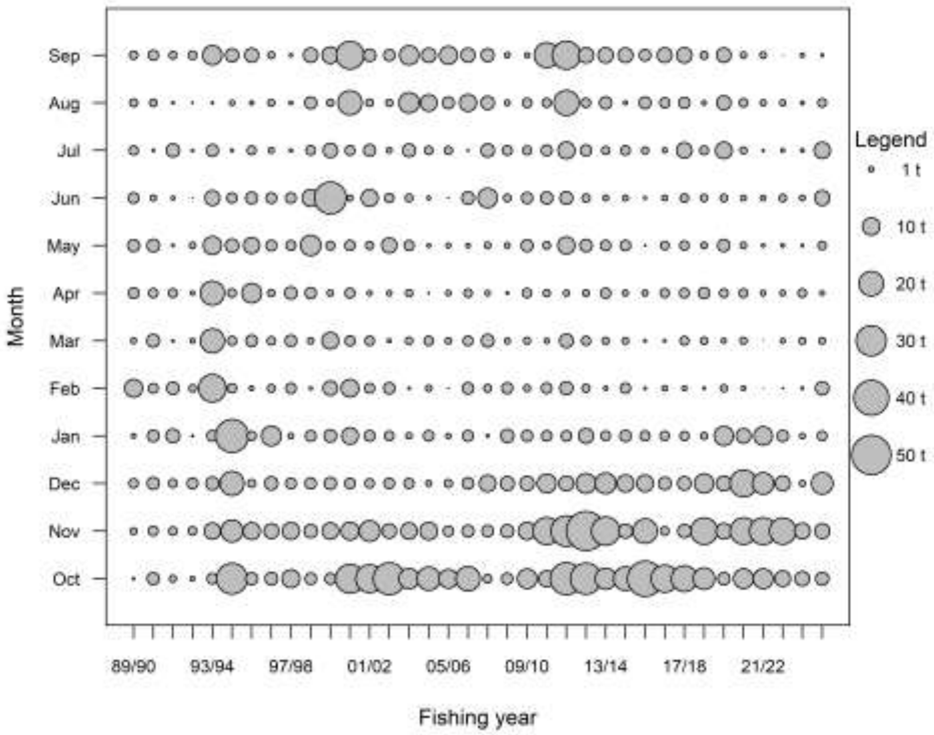

Figure 13: Annual tarakihi catch from the TBGB (TAR 7) fishery by month. The area of the circle is proportional to the catch.

WCSI

For the WCSI fishery, most (70–80%) of the tarakihi catch was taken from the southern areas of the west coast of the South Island (Statistical Areas 033 and 034) (Figure 6). Catches from the northern areas (especially 035 and 036) declined over the last 9 years (2016–17 to 2024–25).

During the 1990s, the tarakihi catch was predominantly taken by the trawl fisheries targeting barracouta and tarakihi (Figure 14). From the mid-2000s to 2018–19, catches were dominated by the target trawl fishery. There was an increase in the tarakihi catch from the barracouta fishery during 2019–20 to 2021–22 (Figure 14).

Most of the tarakihi trawl catch was taken in the 50–200 m depth range, predominantly from the target fishery. The barracouta trawl fishery caught tarakihi over a similar depth range to the target trawl fishery.

The tarakihi catch from the WCSI fishery was taken throughout the year although there was generally a lower proportion of the catch taken during June–August (Figure 15). Some of the vessels in the trawl fleet are likely to have been operating in the hoki fishery during that period.

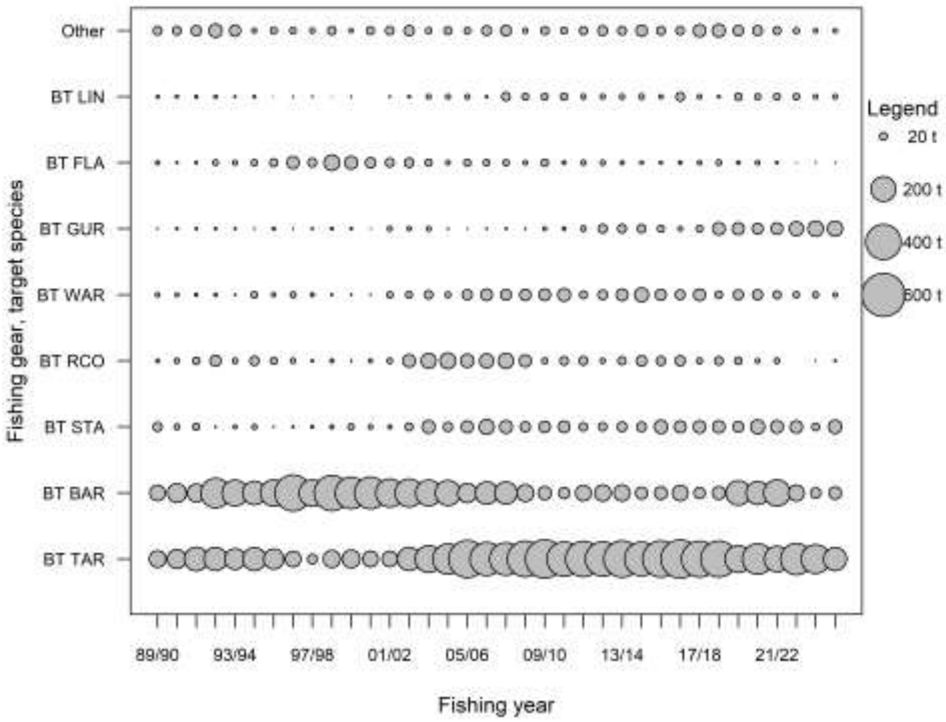

Figure 14: Annual tarakihi catch from the WCSI (TAR 7) fishery by fishing gear (BT, bottom single trawl) and declared target species (GUR, red gurnard; TAR, tarakihi; BAR, barracouta; FLA, flatfish species; WAR, blue warehou; RCO, red cod; STA, stargazer; LIN, ling). The area of the circle is proportional to the catch.

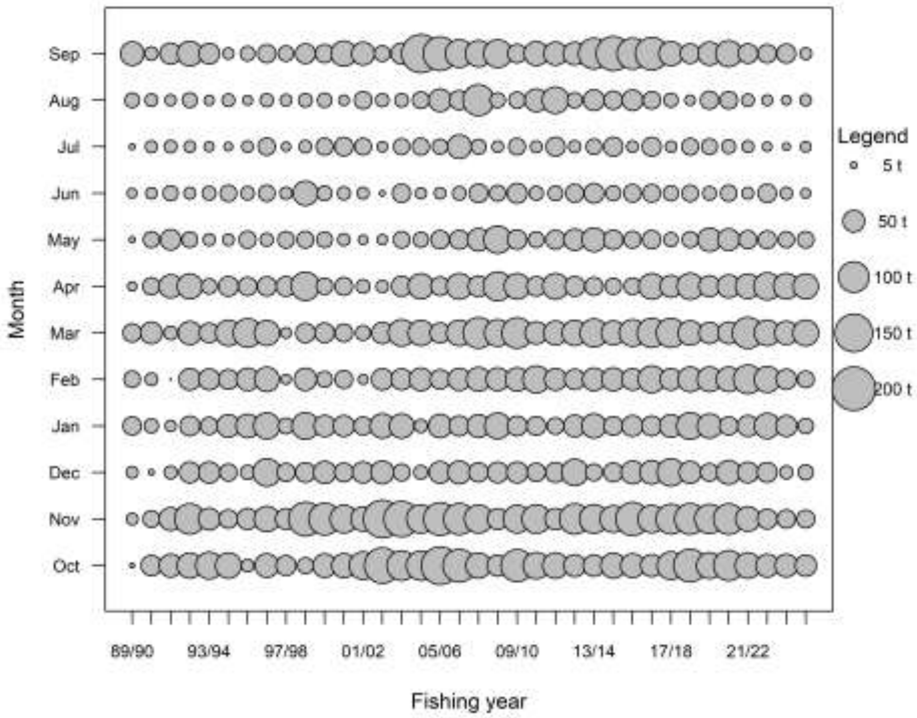

Figure 15: Annual tarakihi catch from the WCSI (TAR 7) fishery by month. The area of the circle is proportional to the catch.

Spatial CPUE

Seasonal and spatial trends in tarakihi trawl catch rates were investigated using trawl-based catch and effort data from the entire western stock and (and immediately adjacent areas). The data set included inshore trawl records with an associated catch of tarakihi from 2007–08 to 2023–24 fishing years. Individual trawl records were assigned to a 0.5º lat/long spatial grid. A Generalised Linear Model was configured to model the relationship between tarakihi catch per tow (natural logarithm) and a range of explanatory variables, most importantly, lat/long grid cell, vessel, month, fishing year were included as categorical variables. Most of the explanatory power of the model was accounted for by the spatial grid cells (93 cells accounting for 34% of the total variation).

The residuals from the model were summarised by month and spatial lat/long grid cell (Figure 16). There are some persistent patterns in the aggregated residuals that indicate seasonal patterns in higher catch rates (positive residuals) and lower catch rates (negative residuals), most notably:

i. Positive residuals off Ninety Mile Beach during March-April and negative residuals during July-October.
ii. Positive residuals off Kaipara Harbour during March-April and negative residuals during September-January.
iii. Negative residuals in the North Taranaki Bight during April-June, with positive residuals during October-December. The area of positive residuals also extended into the South Taranaki Bight during August-January, whereas the area was characterised by negative residuals in February-June.
iv. Positive residuals off southern west coast South Island during March-April and negative residuals during July-October. Conversely, residuals were negative off the northern WCSI during February-April and positive during August-October.
v. Residuals were positive off Marlborough (eastern Cook Strait) during January-March and low from August-October.

The positive residuals off the southern WCSI in March-April correspond to the presence of spawning fish during that period (see Section 5.2). The reciprocal trends in the CPUE residuals between the southern and northern WCSI areas may indicate the movement of tarakihi southwards associated with spawning (Figure 17).

Similarly, the highest proportion of spawning or spent fish off the WCNI in samples during April-June (see Section 5.2), while CPUE is highest during the preceding months. There are reciprocal patterns in CPUE between the northern WCNI areas (highest March-April, lowest September-October) and North Taranaki Bight (lowest in April-June, highest October-December). These may indicate a migration of tarakihi northwards from the North Taranaki Bight to aggregate off Ninety Mile Beach prior to spawning (Figure 17).

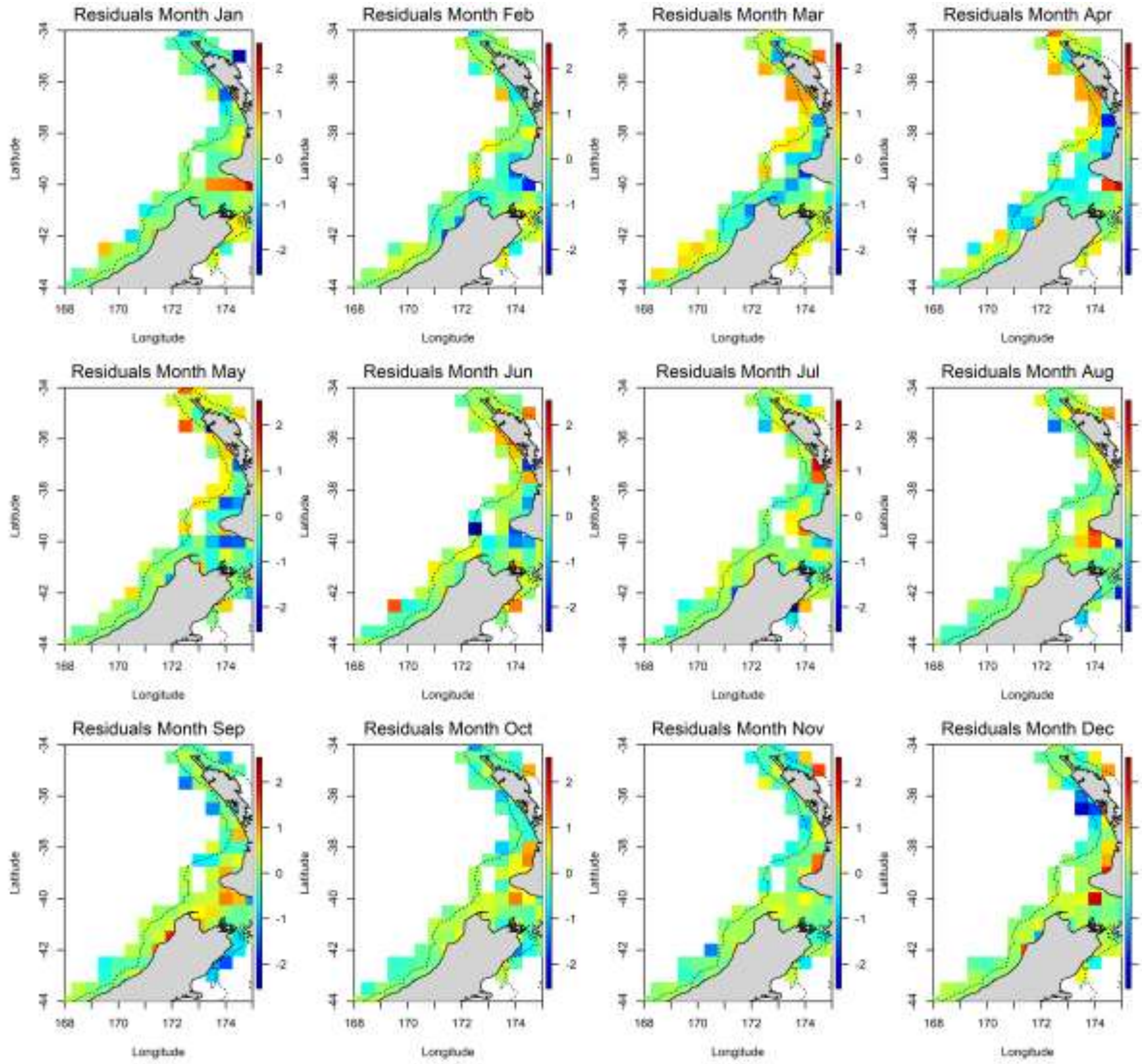

Figure 16: Median spatial CPUE model residuals aggregated by 0.5 lat/long grid cell and month.

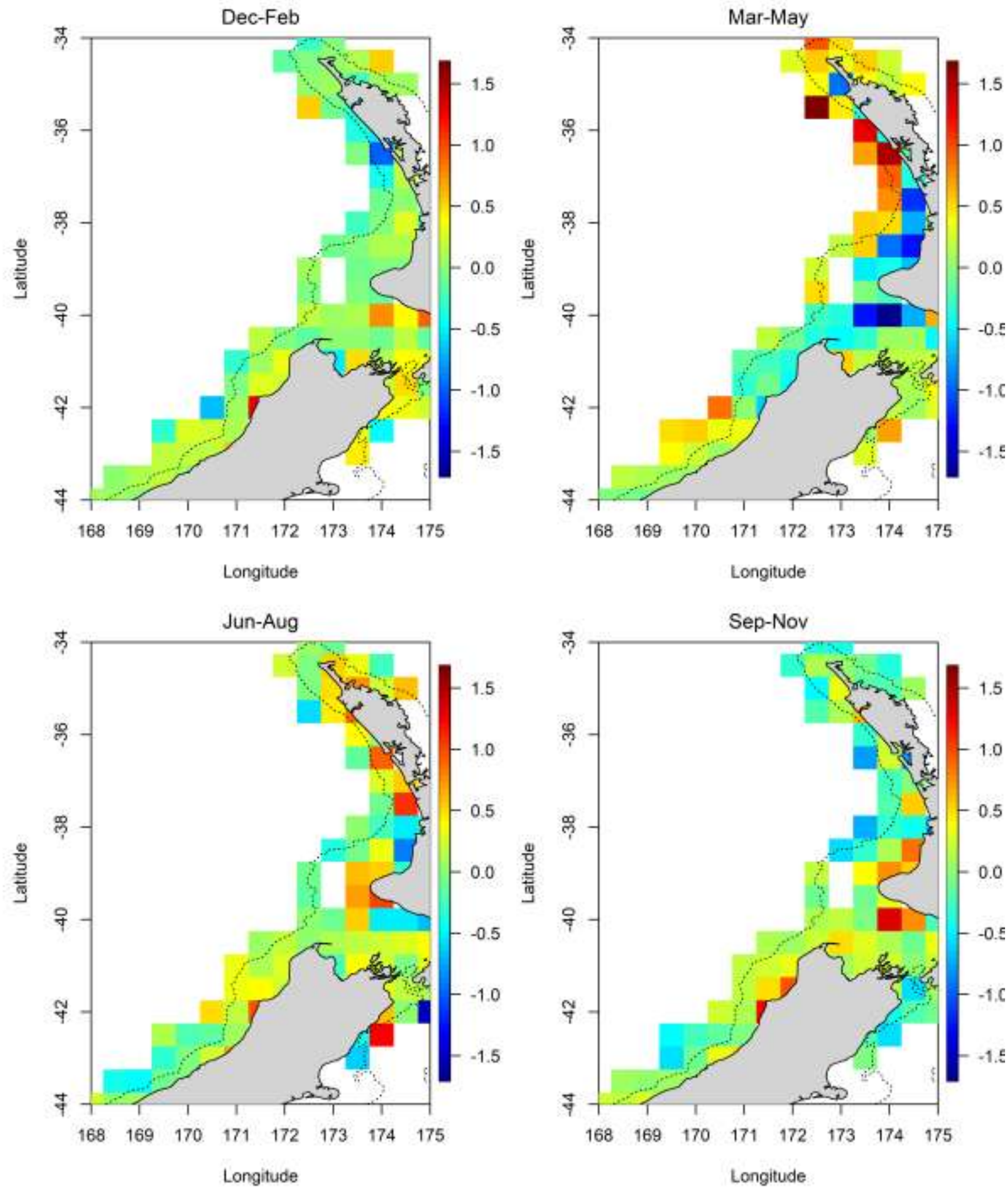

Figure 17: Median spatial CPUE model residuals by aggregated 0.5 lat/long grid cell and season.

3. CPUE ANALYSIS

CPUE analyses were conducted for the trawl fisheries operated in each of the main western tarakihi fishery areas. The CPUE analyses updated and refined the previous analyses conducted by Langley (2021) to include data to the 2024–25 fishing year.

3.1 Methodology

The CPUE analyses were based either on the daily (CELR) format or the trawl event-based data sets specified in Section 2.2. The individual data sets were defined by gear method, statistical area fished, and the target species (Table 2). Each CPUE data set was further limited to a set of (core) vessels based on the continuity criteria specified for each analysis.

A Generalised Linear Modelling (GLM) approach was used to separately model the occurrence of tarakihi catches (presence/absence) and the magnitude of positive tarakihi catches. The dependent variable of the catch magnitude CPUE models was the natural logarithm of catch. For the positive catch CPUE models, a lognormal error structure was initially adopted, although alternative distributions (Weibull, Gamma) were investigated for those model residuals that deviated considerably from the distributional assumptions. The presence/absence of tarakihi catch was modelled based on a binomial distribution.

For the trawl fisheries, CPUE modelling was initially conducted using both data formats. The potential explanatory variables available for inclusion in the daily CPUE models are defined in Table 3, and the trawl event-based variables are presented in Table 4. The two sets of CPUE indices were compared and further analyses were conducted to reconcile significant differences between the daily and event- based indices.

Table 2: Definitions of the data sets included in each of the final CPUE analyses.

Index	Method	Statistical Areas	Target species	Data format	First year	Status
WCNI_Trawl	BT, PRB	045–047	TAR, SNA, TRE	Event	1993/94	Refined
WCSI_Trawl	BT	033–036	TAR, RCO, BAR, WAR, GUR	Day	1989/90	Updated
TAR8_Trawl	BT	037, 039, 040, 041, 801	All, except FLA and JMA	Event	2007/08	New

Table 3: The variables included in the daily CELR format trawl catch and effort data sets.

Variable	Definition	Data type
Vessel	Fishing vessel category	Categoric
FishingYear	Fishing year	Categoric
Month	Month	Categoric
StatArea	Statistical area for day of fishing	Categoric
TargetSpecies	Target species for day of fishing	Categoric
NumTrawl	Natural logarithm of the number of trawls conducted	Continuous
Duration	Natural logarithm of total trawl duration (hours)	Continuous
Speed	Trawl speed (knots)	Continuous
GearWidth	Wingspread of trawl gear (m)	Continuous
GearHeight	Headline height of trawl gear (m)	Continuous
TARcatch	TAR trawl catch (kg)	Continuous
TARbin	Presence (1) or absence (0) of TAR catch in trawl	Categoric

Table 4: The variables included in the trawl event-based CPUE data sets.

Variable	Definition	Data type
Vessel	Fishing vessel category	Categoric
FishingYear	Fishing year	Categoric
Month	Month	Categoric
Latitude	Latitude at the start location of trawl	Continuous
Longitude	Longitude at the start location of trawl	Continuous
Loc2	Start location of trawl categorised by 0.2 degree latitude/longitude cell	Categoric
Latitude1	Start location of trawl categorised by 0.1 degree latitude	Categoric
TargetSpecies	Declared target species for trawl	Categoric
Duration	Natural logarithm of trawl duration (hours)	Continuous
Depth	Fishing depth (m)	Continuous
StartTime	Hour at the start of trawl	Continuous
Speed	Trawl speed (knots)	Continuous
GearWidth	Wingspread of trawl gear (m)	Continuous
GearHeight	Headline height of trawl gear (m)	Continuous
TARcatch	Scaled estimated TAR trawl catch (kg)	Continuous
TARbin	Presence (1) or absence (0) of TAR catch in trawl	Categoric

A step-wise fitting procedure was implemented to configure each of the CPUE models. The fitting procedure initially considered the range of potential explanatory variables (Table 3, Table 4) with the continuous variables typically parameterised as a third order polynomial function. The categorical variable *FishingYear* was included in the initial model and subsequent variables were included in the model based on the improvement in the deviance explained. Additional variables were included in the model until the improvement in the R^2 statistic was less than 0.5%.

The influence of each of the main variables in the CPUE models were examined following the approach of Bentley et al. (2012). Annual trends in the residuals of each model were examined with respect to target species and statistical area.

The final (combined) indices were determined from the product of the positive catch CPUE indices and the binomial indices following the approach of Stefansson (1996). The confidence intervals associated with the combined indices were determined using a bootstrapping approach.

3.2 WCNI trawl

The WCNI Trawl CPUE indices were derived from the trawl event-based data available from 1993–94. The derivation of the WCNI Trawl CPUE data set is described in Appendix 1. The CPUE model diagnostics are also presented in Appendix 1.

The positive catch and binomial models accounted for a considerable change in the operation of the WCNI tarakihi fishery, particularly since 2009–10, with a northern shift in fishing effort (to Ninety Mile Beach) and an increase in the proportion of deeper (100–250 m) trawls corresponding to an increase in the proportion of trawls targeting tarakihi. Further, the more efficient vessels were increasingly dominant in the fishery from 2015–16 onwards (see Appendix 1).

The resulting positive catch indices decline from the mid-2000s to a low point in 2018–19 and then increase slightly in the more recent years (Figure 18). The extent of the decline in the positive catch indices is moderated in the combined delta-lognormal indices by a small increase in the probability of catching tarakihi (occurrence model) since 2012–13 (Figure 18). The overall decline in tarakihi CPUE is evident for the three constituent target fisheries (TAR, SNA and TRE) and for the three constituent Statistical Areas (045, 046 and 047).

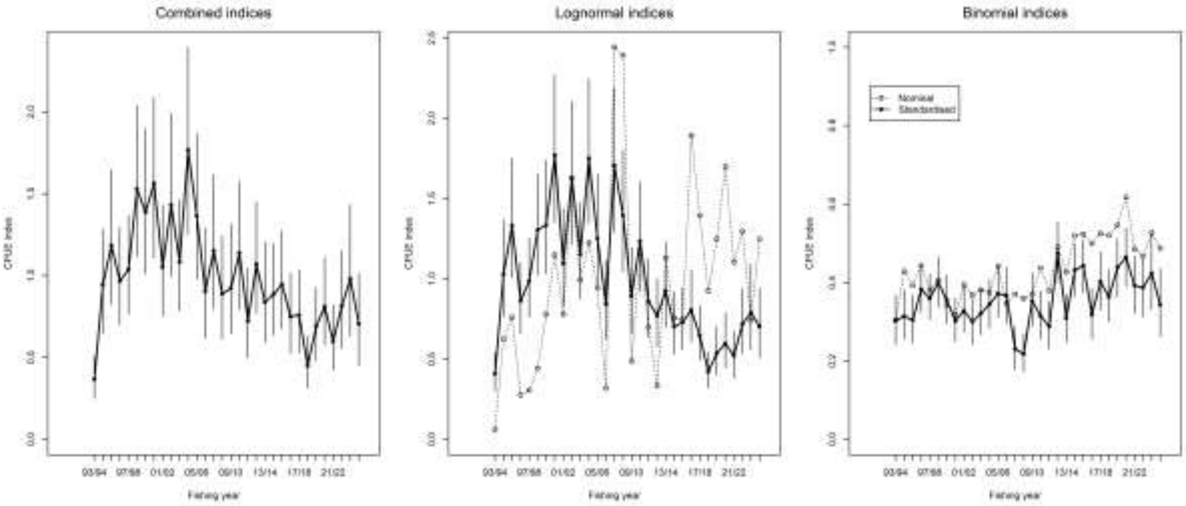

Figure 18: A comparison of: (middle panel) the WCNI Trawl positive index and the geometric mean of the annual catch per trawl; (right panel) the binomial index and the annual proportion of positive catch records in the data set; and (left panel) the combined index. The error bars represent the 95% confidence intervals associated with each index. The annual indices are provided in Table A10 (Appendix 1).

3.3 TAR8 trawl CPUE indices

Initially, CPUE indices for TAR 8 were derived from the daily catch and effort data set. However, the indices were not consistent with the indices derived from the Trawl event data set from 2007–08 onwards, seemingly due to changes in the depth distribution of trawls that were not adequately accounted for by the declared target species within the daily catch and effort data. On that basis, the trawl event CPUE analysis was progressed as it was considered more likely to yield a useful set of CPUE indices.

The derivation of the TAR 8 Trawl CPUE data set is described in Appendix 2.

The depth distribution of the trawl effort records differs between years, with a higher proportion of deeper (120–170 m) trawls during 2011–12 to 2018–19. The deeper trawls predominantly targeted tarakihi, while shallower (30–70 m) trawls targeted red gurnard (see Appendix 2 Figures A11 and A14). For both the positive catch (lognormal) and occurrence (binomial) models, depth was the most significant explanatory variable moderating the trends in the annual indices, particularly for the positive catch model (Figure 19).

The CPUE indices from the positive catch (lognormal) and occurrence (binomial) models are somewhat contradictory in trend with the positive catch indices increasing during 2007–08 to 2015–16 while the occurrence indices decline (Figure 19), resulting in a less pronounced increase in the combined delta-lognormal CPUE indices (relative to the lognormal indices) during the period.

An examination of the model residuals revealed that most of the trend in the CPUE indices was attributable to the trends in catch rates of tarakihi taken as a bycatch of the red gurnard trawl fishery. In contrast, catch rates were relatively stable from the target tarakihi fishery (see Appendix 2 Figure A13). These differences may relate to differences in the length/age composition of the catch from the two fisheries. Limited catch sampling from the TAR 8 trawl fisheries has revealed that the shallower trawls predominantly catch younger tarakihi, while the target trawls catch a broad range of age classes (see Section 6.3). Annual variation in recruitment of tarakihi may therefore have considerably more influence on the catch rates of tarakihi in shallower areas.

Overall, the TAR 8 CPUE indices were considered less informative than the indices from the WCNI and WCSI fisheries, due to the relatively short time series and the apparent heterogeneity in the indices compiled from multiple fisheries (structured by depth or target species).

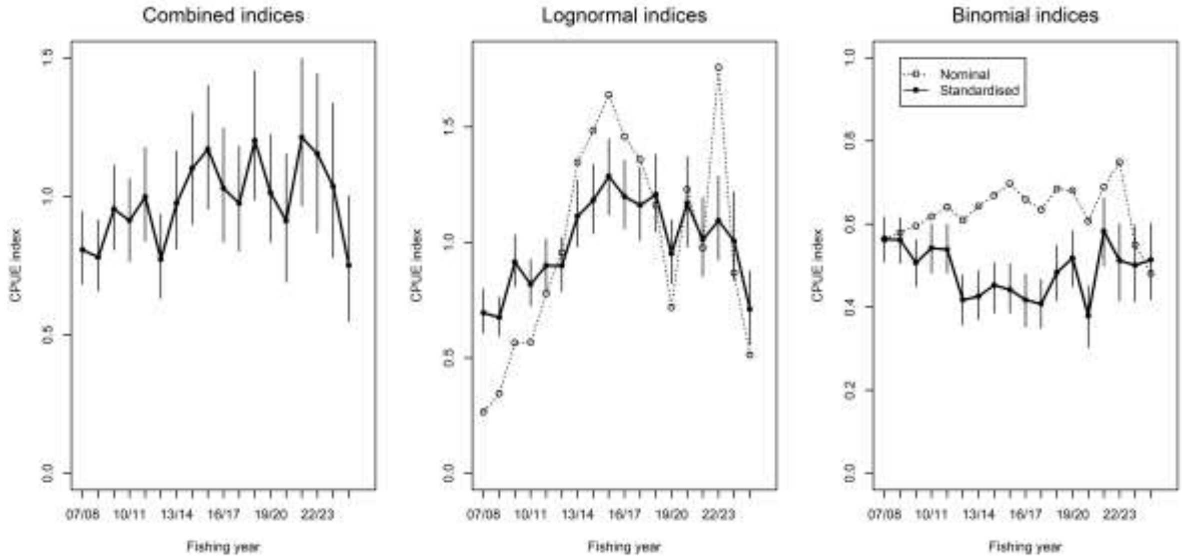

Figure 19: A comparison of: (middle panel) the TAR8 Trawl positive index and the geometric mean of the annual catch per trawl; (right panel) the binomial index and the annual proportion of positive catch records in the data set; and (left panel) the combined index. The error bars represent the 95% confidence intervals associated with each index. The annual indices are provided in Table A10 (Appendix 2).

3.4 WCSI trawl

The WCSI Trawl CPUE indices were derived from the daily catch and effort data. The derivation of the WCSI Trawl CPUE data set is described in Appendix 3. The CPUE model diagnostics are also presented in Appendix 3.

The most influential variable included in both the positive catch (lognormal) and occurrence (binomial) models was target species. There was a substantial shift in the operation of the fishery from targeting barracouta during 1989–90 to 2004–05 to targeting tarakihi since 2009–10 (see Appendix 3 Figure A20). The inclusion of the target species in the positive catch model softens the general increase in the nominal catch rate of tarakihi, while reducing the probability of catching tarakihi in recent years predicted by the occurrence model (Figure 20). The CPUE indices from the positive catch model were also influenced by the contraction of the trawl fleet with the more efficient vessels remaining in the fishery.

The combined CPUE indices fluctuate over the entire period, with peaks in tarakihi CPUE in 1996–97 to 1998–99 and 2002–23 to 2005–06 (Figure 20). More recently, CPUE increased from 2010–11 to 2018–19 and then declined to a relatively low level in 2024–25.

Trawl event-based data are available from the fishery since 2007–08. A separate set of CPUE indices were derived from the event-based data set. The resulting indices are comparable to the daily indices from the corresponding period.

The daily CPUE indices are also comparable to the time series of biomass indices from the tarakihi biomass indices from *Kaharoa* WCSI inshore trawl survey (Figure 21).

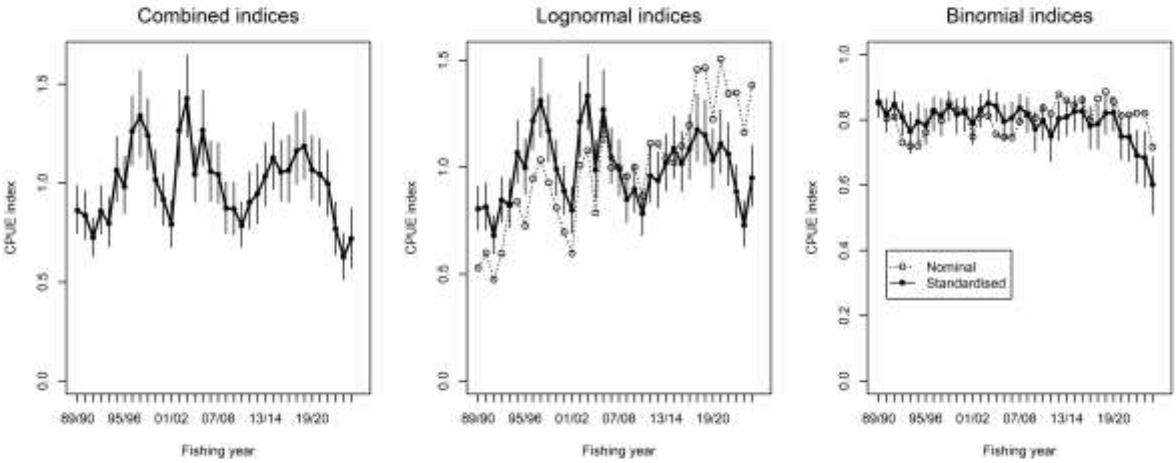

Figure 20: A comparison of: (middle panel) the WCSI Trawl positive index and the geometric mean of the annual catch per day; (right panel) the binomial index and the annual proportion of positive catch records in the data set; and (left panel) the combined index. The error bars represent the 95% confidence intervals associated with each index. The annual indices are provided in Table A15 (Appendix 3).

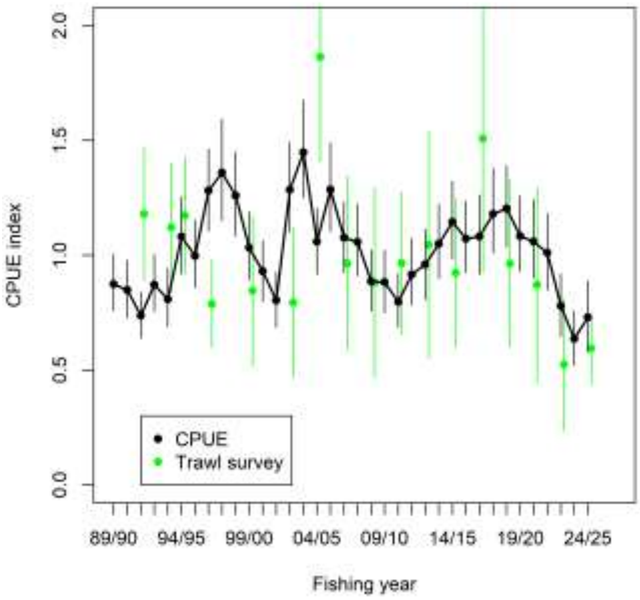

Figure 21: Comparison between the WCSI Trawl CPUE indices and the WCSI *Kaharoa* trawl survey biomass indices (WCSI area of survey only).

4. STOCK STRUCTURE

The stock structure of tarakihi was most recently reviewed by Langley (2022). Since then, additional data are available from a comprehensive catch sampling programme in 2023–24 and 2024–25 that simultaneously sampled tarakihi from the main fisheries around the North Island and South Island, supplementing previous sampling conducted in 2018–19 and 2019–20. A large number of fish were aged from the two programmes; a total of 8093 males and 9446 females. For the combined data set, the average length-at-age was derived for each fishery by sex (Figure 22).

No appreciable difference in average length was evident from the two sampling programmes. However, there are persistent differences in average fish length at age between fisheries. Overall, males and females from the west coast fisheries (WCSI, TAR 8 and WCNI) are larger than fish from the east coast fisheries (TAR 3, COOK, BPEC and ENLD) (Figure 22). Notably, the differences are considerable around the northern North Island between the WCNI and ENLD fisheries.

The persistent differences in average length at age between these areas indicates regional scale differences in growth and a lack of broad scale mixing of fish between areas, particularly western and eastern areas.

The growth rates for both male and female tarakihi are broadly similar for the ENLD, BPEC, and COOK fisheries off the east coast, at least for fish up to about 15 years of age (Figure 22). This is consistent with the assumption of an eastern stock of tarakihi, with considerable mixing of fish between the areas. The male fish from the TAR 3 fishery also exhibit similar growth rates to the other areas, although the female growth rate is considerably higher.

For the three western fisheries (WCSI, TAR 8 and WCNI), the growth rates of female tarakihi are similar, although there are spatial differences for the growth rates of male fish, with smaller fish sampled from the WCSI fishery compared to the WCNI fishery and intermediate growth from TAR 8 (Figure 22). This may indicate a degree of spatial segregation of the western tarakihi sub-population(s).

The development of an assessment model for the western stock of tarakihi enables the integration of the range of abundance indices and age composition data. This provides estimates of annual recruitments that can be then directly compared with the relative strength of individual year classes estimated from the eastern stock assessment. These comparisons are provided in Section 7.8.

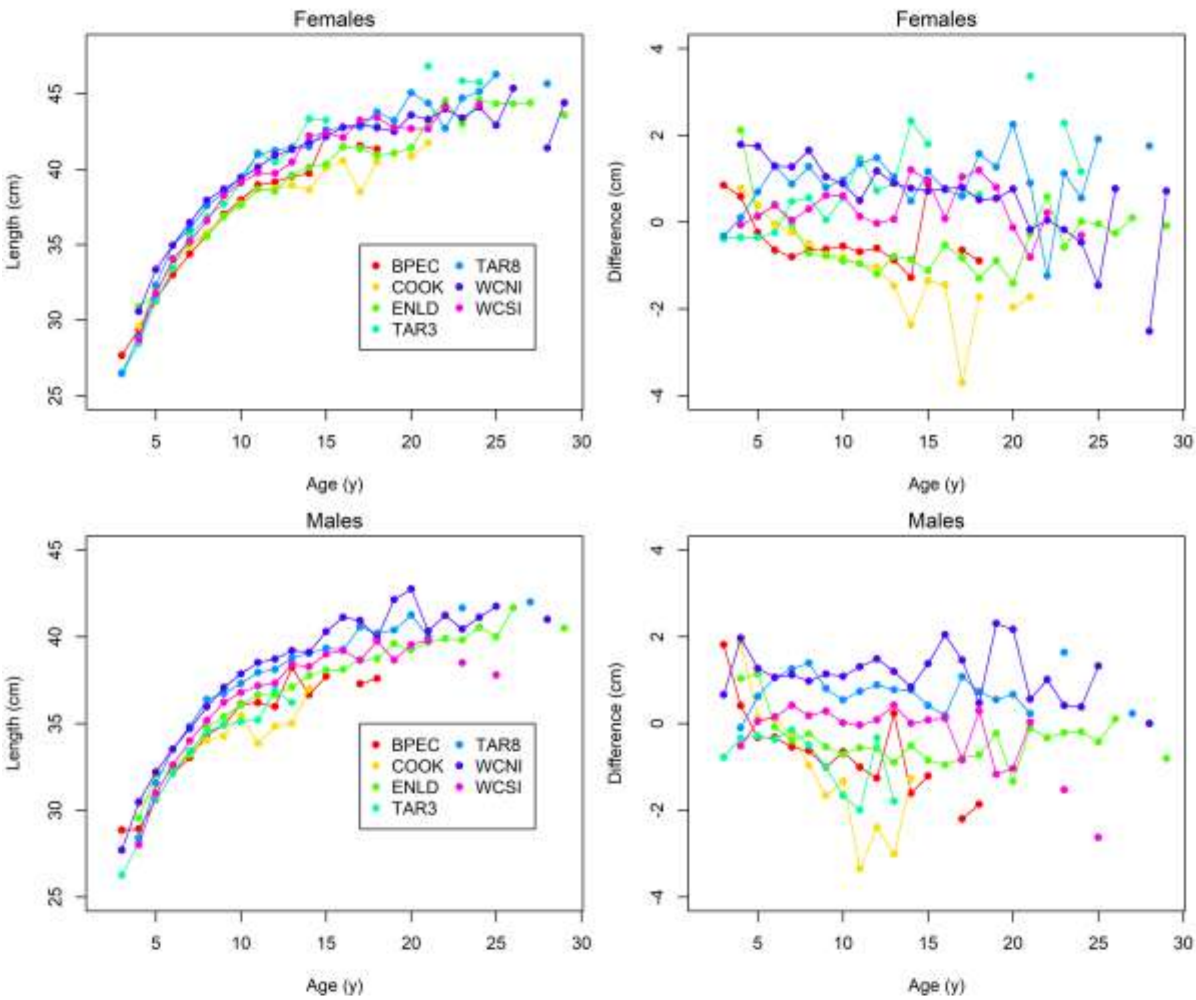

Figure 22: Average length at age for female (top) and male (bottom) tarakihi by fishery from the recent tarakihi catch sampling programmes (left panels). The right panels present the results as a difference from the overall average length-at-age (all data combined).

5. BIOLOGICAL PARAMETERS

5.1 Age and Growth

Protocols for the ageing of tarakihi otoliths are detailed in Walsh et al. 2016. Those protocols were applied to age the otolith sets collected from the west coast South Island, Tasman Bay & Golden Bay *Kaharoa* trawl surveys (survey years 2000, 2003, 2005, 2007, 2009, 2011, 2013, 2015, 2017 and 2019). Ageing was conducted by NIWA.

The aged data set from the *Kaharoa* trawl surveys was used to estimate growth parameters for male and female tarakihi in TAR 7 (Table 5). The otoliths were collected during March-April and, following the ageing protocol aged relative to a birthday of 1 May. Most of the fish sampled from the TBGB were aged 1–3 years, whereas the WCSI area included a broad range of age classes.

Aged fish from the commercial fishery data sets were not included in the estimation of growth parameters. Data from the commercial fishery is likely to positively bias the estimates of growth for the younger fish due to the size based selectivity of the trawl method and the retention of fish above the Minimum Legal Size (MLS) for tarakihi (25 cm F.L.).

Table 5: A summary of the *Kaharoa* WCSI trawl survey aged otolith data set used in the estimation of TAR 7 growth parameters by survey year and area (TBGB, Tasman Bay and Golden Bay; WCSI, West Coast South Island).

Year	TBGB		WCSI		Total	
	Male	Female	Male	Female	Male	Female
2000	0	0	104	118	104	118
2003	23	19	85	104	108	123
2005	19	15	74	93	93	108
2007	32	23	72	98	104	121
2009	38	33	116	186	154	219
2011	50	57	82	174	132	231
2013	48	35	125	343	173	378
2015	59	72	111	210	170	282
2017	60	73	107	181	167	254
2019	63	73	98	196	161	269
Total	392	400	974	1 703	1 366	2 103

For each sex, growth parameters were estimated using a nonlinear least squares model (*nls* function in R). Initially, growth parameters were estimated assuming a Von Bertalanffy growth model. However, there were persistent patterns in the model residuals for both sexes; growth was over-estimated for ages 5–20 years. There was a substantial improvement in the fit to the data using a Schnute growth model (Figure 23) that allows for a more flexible structure (with the inclusion of the additional shape parameter *b*) (Table 6).

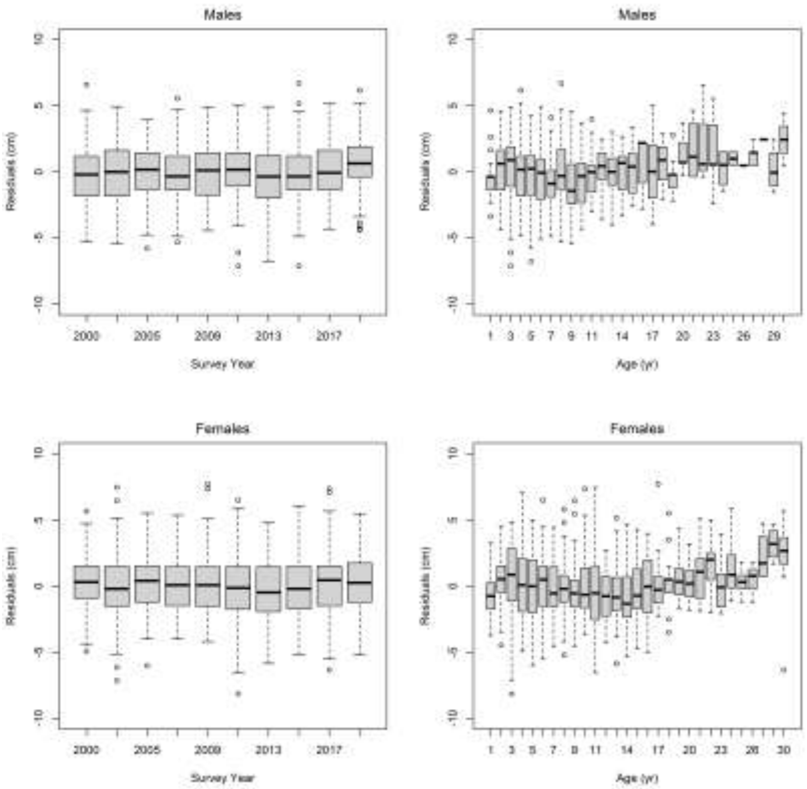

Figure 23: Boxplots of the residuals for the Schnute growth models by survey year (left panels) and age (right panels) for male (top) and female (bottom) tarakihi.

Table 6: Estimated Schnute growth parameters for male and female tarakihi (TAR 7W) and the standard error of the estimate in brackets. *L min* and *L max* were derived for age 1 and 40 y, respectively.

Parameter	Males	Females
L min	12.56 (0.17)	12.63 (0.19)
L max	42.94 (0.28)	45.85 (0.236)
k	0.162 (0.008)	0.141 (0.005)
b	1.88 (0.092)	1.869 (0.075)

The estimated Schnute growth rates are equivalent for male and female fish up to 5 years of age. For both sexes, growth rates attenuate with increasing age, while male fish attain a smaller maximum length relative to female fish (Figure 24).

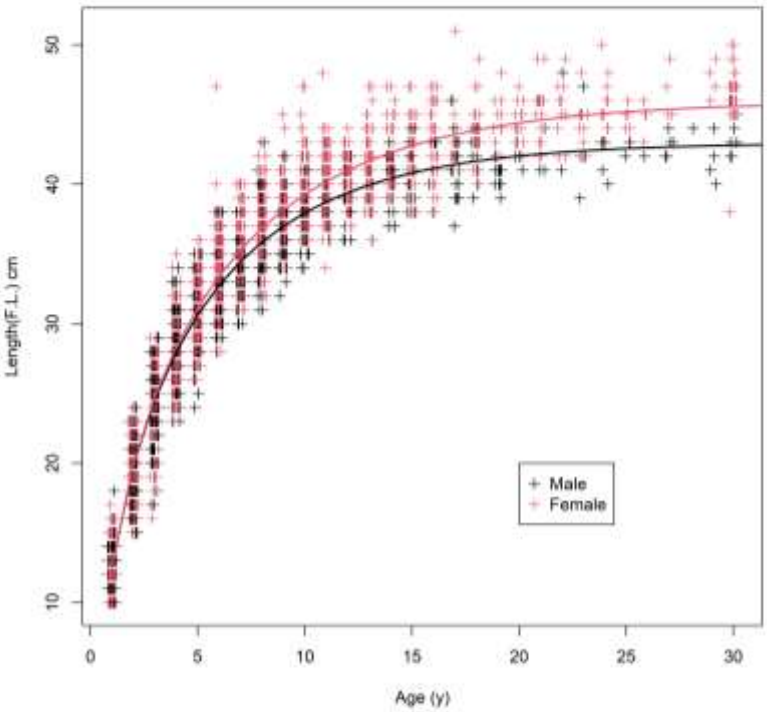

Figure 24: Age-length observations and estimated Schnute growth functions for male and female tarakihi.

The Schnute growth functions were compared to the average length at age of male and female tarakihi sampled from the WCSI, TAR 8 and WCNI fisheries in 2018–19 to 2019–20 (McKenzie et al. 2021) and 2023–24 to 2024–25 (McKenzie et al. 2026). For female fish, the age data from the commercial fisheries are consistent with the estimated growth model (Figure 25). However, for male fish the growth model estimates higher growth rates than observed from the commercial fishery, especially from the WCSI fishery (Figure 25).

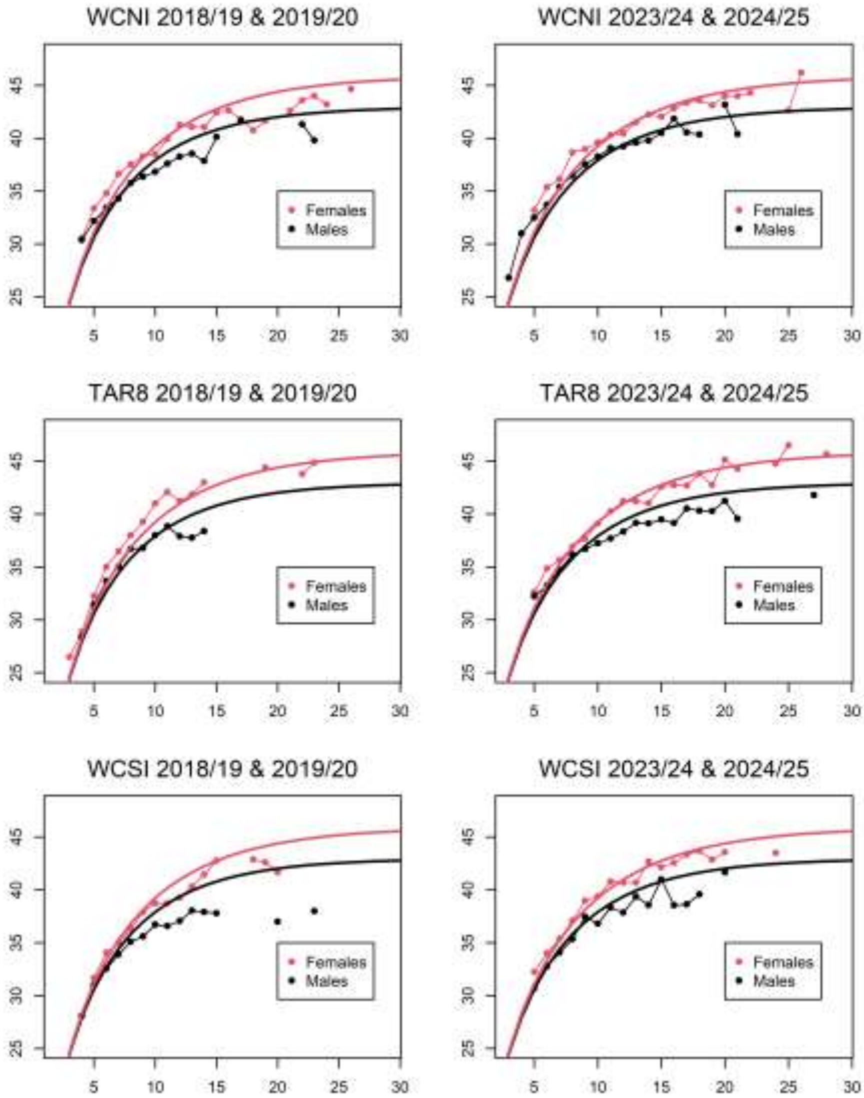

Figure 25: A comparison of the Schnute growth functions for female and male tarakihi (lines) with the average length at age (points) of tarakihi sampled from the WCNI, TAR 8 and WCSI fisheries from 2018–19 and 2019–20 (left panels) and 2023–24 and 2024–25 (right panels).

5.2 Maturity and spawning

The 2018–19 to 2019–20 market sampling programme encompassed the main tarakihi fisheries around mainland New Zealand (McKenzie et al. 2021). For each sampled landing, otoliths were collected from a random sample of 60 fish and the length (fork length), sex and gonad maturity stage were recorded. Tarakihi reach sexual maturity from a length of about 30 cm (FL). For female fish above this threshold, seasonal patterns in ovarian development were examined from the sampled landings, summarised by fishery area and month.

For the WCSI fishery, actively spawning fish (ripe, running ripe and partially spent ovaries) dominated samples collected during April-June (Figure 26). Few actively spawning fish were sampled from the WCNI fishery, while spent and partially spent fish were mainly sampled in May and June. Limited spawning or spent fish were sampled from the TAR 8 fishery (Figure 26).

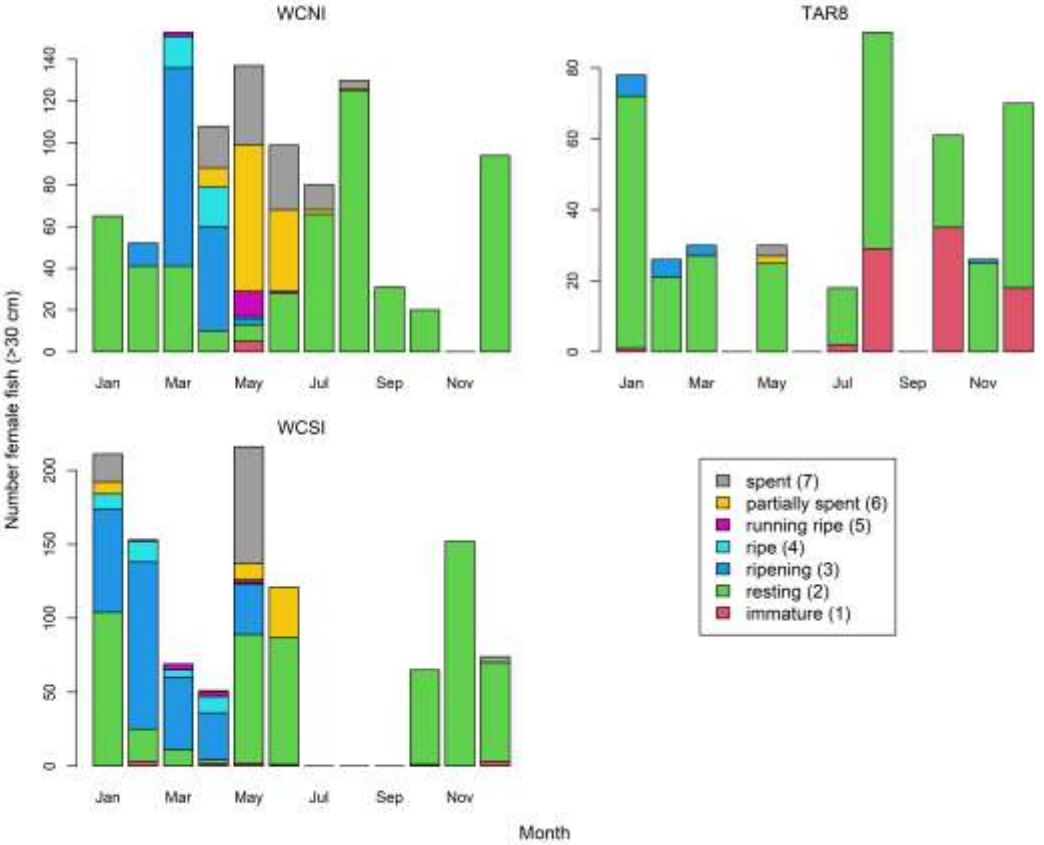

Figure 26: The number of female fish (> 30 cm FL) in each ovarian stage sampled by fishery and month from the 2018–19 and 2019–20 catch sampling programme.

The *Kaharoa* WCSI trawl surveys in March-April coincided with the main tarakihi spawning period in TAR 7. The survey sampled a broad range of length classes including small tarakihi, while the commercial catch is restricted to fish larger than the Minimum Legal Size of 25 cm (FL). The trawl survey age data set was analysed to determine the proportion of mature female fish (defined as ovarian stages 3–6) in each age class.

Most 1–4 year old female fish were either immature (stage 1) or were in a resting state (2) (Figure 27). The proportion of mature fish increased from 5 years of age with full maturity attained at about 10 years. The proportion mature was approximated with a logistic function, with estimated parameters of 50% maturity at 6.14 y and width of 3.38 y (Figure 27).

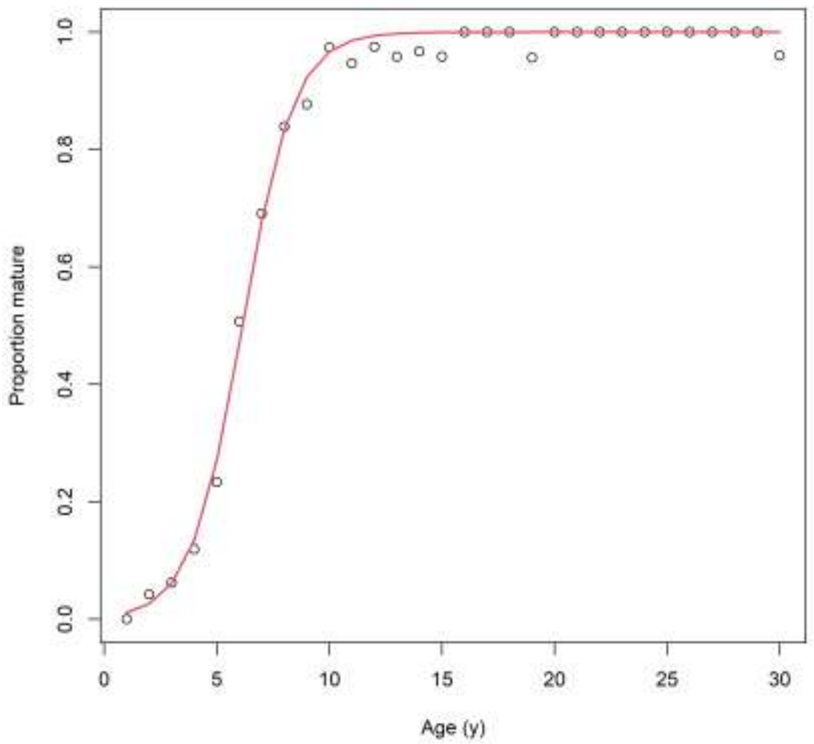

Figure 27: Proportion of female fish mature by age class from the *Kaharoa* WCSI trawl survey aged data set (points). The red line represents a logistic function fitted to the data.

5.3 Length-weight relationships

Relationships between tarakihi fish length (FL in cm) and weight (g) are available from individual WCSI trawl surveys from 1997 to 2023. There are no appreciable differences in the relationships derived for the individual surveys. The relationships between fish length and weight are also similar between the WCSI and WCNI trawl surveys (Jones et al. 2022, 2024), although fish from the WCNI trawl surveys were slightly (5–10%) lighter above about 35 cm (F.L.). This may be attributable to the timing of the two surveys with tarakihi in spawning condition from the WCSI survey, while the WCNI trawl survey was conducted prior to the spawning period (November).

6. DATA COMPILATION

6.1 Commercial catch history

Francis & Paul (2013) compiled reported landings of tarakihi by the domestic and foreign fleets by Fishery Management Areas (FMAs) from 1931–1982. For the domestic fleet, the FMA catches were derived based on the port of landing of the catch, whereas foreign catches were reported by management areas. Prior to 1983, catches were summarised by calendar year, while more recent catches are reported by fishing year (to 2024–25) and Quota Management Area (QMA) (Fisheries New Zealand 2025). Catches by fishing year were assigned to the calendar year at 1 January (e.g., catches from the 2024–25 fishing year were assigned to 2025).

Reported catches from each FMA/QMA were apportioned amongst the constituent fisheries based on either the Port of Landing (pre-1983) or Statistical Area (Table 7). The catches from TAR 1 and TAR 7 are partitioned between the western and eastern stocks. To ensure consistency with the eastern tarakihi stock assessment an equivalent approach was applied to apportion catches between the relevant fisheries.

Table 7: Summary of the methodology applied to apportion the annual commercial catches between fisheries for the western tarakihi stock assessment. Fisheries included in the eastern stock assessment are italicised.

Period	FMA	QMA	Fishery1	Fishery2	Fishery3	Comment
1932–1982	7		WCSI	TBGB	*TAR7E_Cook*	Partitioned based on Region/Port of Landing
1932–1982	8		TAR 8			
1932–1982	9		WCNI			
1983–2025		TAR 1	WCNI	*TAR1E_ENLD*	*TAR1E_BPLE*	Partitioned based on estimated catch distribution
1983–2025		TAR 7	WCSI	TBGB	*TAR7E_Cook*	WC = Stat Area 032–036 TBGB = Stat Area 037, 038 Cook = Stat Area 017
1983–2025		TAR 8	TAR 8			

Due to the assignment of catches based on port of landing, there is considerably more uncertainty associated with the fishery specific catches prior to 1983. There was a general increase in the catch from the WCSI fishery from 1970 until the early 2000s (Figure 28). In contrast, there was a large initial domestic catch attributed to the TBGB fishery in 1967 and 1968 based on landed catches in

Nelson. Most likely, those catches were predominantly taken in the first two years of operation of two large domestic trawlers (*Sea Harvester 1* and *Sea Harvester II*). The vessels were based in Nelson but were predominantly targeting tarakihi off the west coast of the South Island (Johnson 2004, Francis & Paul 2013). Further, there was a sharp drop in the catches attributed to the TBGB fishery in 1983 corresponding to the introduction of the FSU reporting system, rather than attribution of catches based on port of landing. Thus, it is likely that most of the catch attributed to TBGB was from the WCSI fishery.

For TAR 8, annual catches increased considerably in the 1970s, with an exceptionally large catch in 1977 (Figure 28). A considerable proportion of the TAR 8 catch during the 1970s was taken by foreign vessels (Francis & Paul 2013), probably Japanese and Soviet trawlers fishing in the South Taranaki Bight prior to the declaration of the New Zealand Exclusive Economic Zone in 1978.

The WCNI tarakihi fishery developed in the mid-1950s. Most of the catch was taken by domestic trawlers until the 1970s when a considerable proportion of the catch was taken by foreign vessels. Catches increased during the late 1990s and fluctuated about the higher level during the 2000s and 2010s. There was a sharp decline in catch in 2023–24 and 2024–25 following the retirement of one of the main vessels operating in the fishery (Figure 28).

An additional level of unreported catch was assumed for each fishery; unreported catches were assumed to represent 20% of the annual reported catch prior to the introduction of the QMS and 10% of the annual reported catch in the subsequent years (Figure 28). These assumptions are consistent with the approaches used in other inshore finfish stock assessments (e.g. SNA 1, SNA 8 and SNA 7).

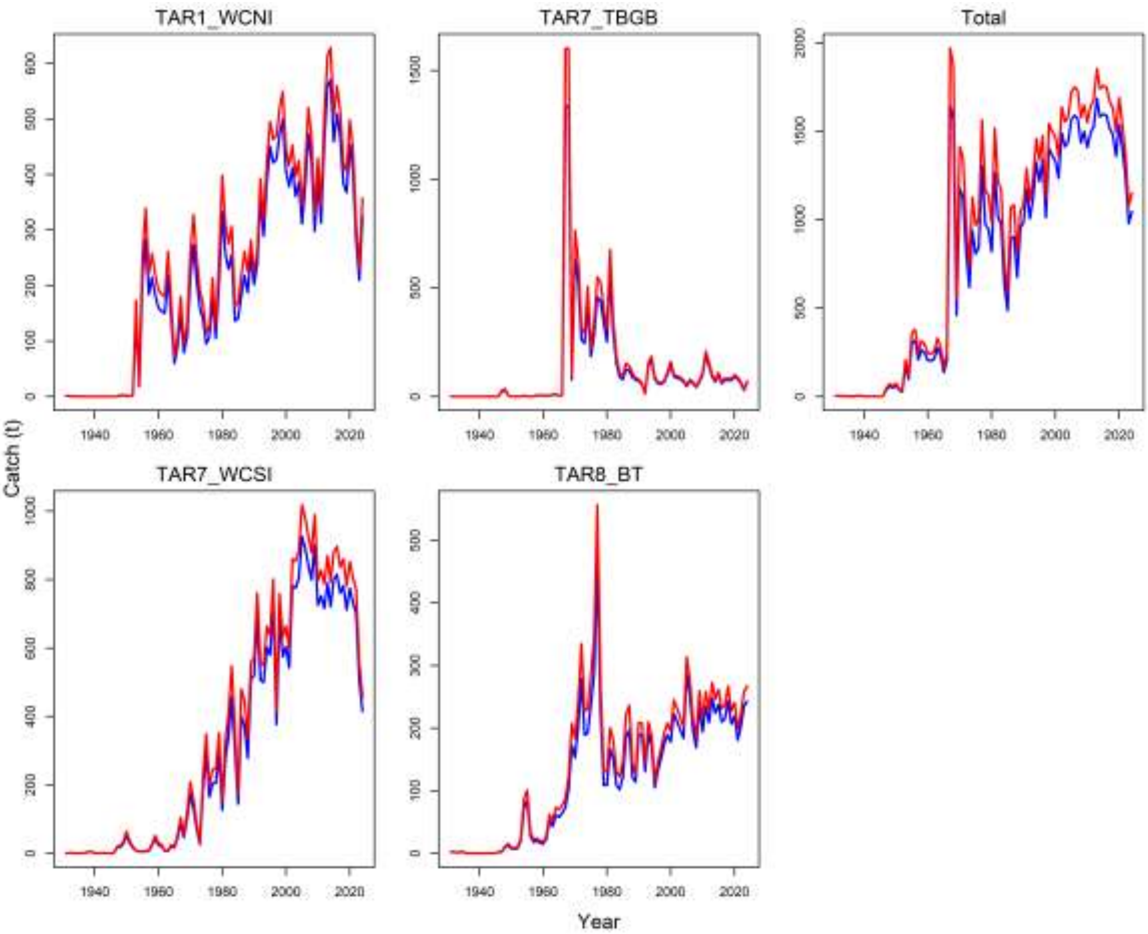

Figure 28: Annual commercial catches by fishery compiled for the western tarakihi assessment model. The blue line represents the base level of catch and the red line includes the additional level of unreported catch assumed in the assessment (20% pre 1986–87 and 10% for subsequent years).

3.2 Non commercial catch

Recreational catch estimates for TAR 7 and TAR 8 are available from National Panel Surveys conducted in 2011–12, 2017–18 and 2022–23 (Fisheries New Zealand 2025). The catch estimates are relatively low. For each fishery, a constant recreational catch of 10 t per annum from 1965 to 2025 was assumed. Recreational catch estimates for FMA 9 are negligible (almost all TAR 1 catch from FMA 1). There was no explicit customary catch included in the assessment.

6.2 Trawl survey indices, length and age compositions

Since 1992, a time series of inshore trawl surveys has been conducted by *Kaharoa* off the west coast South Island (WCSI) and in Tasman Bay/Golden Bay (TBGB) within the 20–70 m depth range (Stevenson & Hanchet 2000, MacGibbon & Stevenson 2013, Stevenson & MacGibbon 2015, 2018, MacGibbon 2019, MacGibbon et al. 2022, 2024, 2026). Initially, separate sets of tarakihi biomass indices and scaled length compositions (male, female and unsexed) were derived for the two sub areas, WCSI and TBGB, following the methodology of Francis & Fu (2012).

The WCSI biomass index from 2005 is considerably higher than the two adjacent indices (2003 and 2007) (Table 8). An examination of the survey data revealed a significant proportion of the additional biomass was within the northern WCSI strata and the abundance of individual year classes was substantially higher than from the adjacent surveys. This indicated an increase in the availability of tarakihi to the 2005 trawl survey, potentially due to an increase in the proportion of the tarakihi biomass within the survey area.

The TBGB area is dominated by juvenile, primarily 1- and 2-year-old tarakihi. Two additional sets of age specific indices were derived separately for 1 y and 2 y fish (both sexes combined), representing potential recruitment indices. Both sets of indices are imprecise, with high associated coefficients of variation (CVs) (Table 8). The indices for both of these year classes were very low from 2016–2024 (Figure 29).

Similarly, a set of 2 y indices was also derived for the WCSI portion of the survey area (Table 8). The overall magnitude of the indices is lower than for the TBGB 2 y indices. There is a very weak correlation between the two sets of indices (correlation coefficient 0.30) (Figure 30). Notably, the most recent index (2023 year class) was higher for the WCSI than for TBGB.

Table 8: West coast South Island (WCSI) and Tasman Bay/Golden Bay (TBGB) trawl survey biomass indices and 1 y and 2 y recruitment indices and the associated coefficient of variation (% in brackets). Biomass in tonnes, numbers of fish are in thousands.

Survey	Model Year	WCSI biomass	TBGB biomass	TBGB Age 1 y, number	TBGB Age 2 y, number	WCSI Age 2 y, number
KAH9204	1992	1 296 (13)	113 (86)	181.6 (115)	842.4 (112)	179.9 (35)
KAH9404	1994	1 231 (13)	163 (58)	128.7 (141)	435.9 (69)	84.3 (94)
KAH9504	1995	1 288 (11)	101 (34)	316.4 (268)	468.2 (79)	4.0 (48)
KAH9701	1997	865 (12)	222 (34)	493.9 (49)	443.3 (50)	50.8 (252)
KAH0004	2000	928 (20)	36 (32)	59.9 (59)	168.6 (57)	226.1 (204)
KAH0304	2003	872 (21)	40 (52)	7.5 (95)	118.2 (75)	68.3 (64)
KAH0503	2005	2 047 (13)	3 (51)	2.6 (80)	14.0 (86)	10.9 (43)
KAH0704	2007	1 059 (20)	130 (98)	27.8 (74)	186.1 (99)	86.4 (73)
KAH0904	2009	966 (24)	122 (33)	560.6 (64)	510.5 (41)	53.8 (110)
KAH1104	2011	1 060 (16)	128 (35)	324.4 (114)	605.4 (108)	214.1 (72)
KAH1305	2013	1 148 (24)	124 (50)	46.5 (59)	726.3 (55)	135.7 (29)
KAH1503	2015	1 013 (18)	47 (45)	481.4 (33)	76.6 (92)	60.0 (40)
KAH1703	2017	1 656 (20)	202 (31)	89.1 (86)	942.3 (62)	73.9 (124)
KAH1902	2019	1 058 (19)	35 (31)	72.6 (49)	74.4 (56)	78.4 (95)
KAH2103	2021	957 (25)	11 (52)	6.4 (46)	17.4 (112)	0.7 (122)
KAH2302	2023	575 (28)	0 (-)	0 (-)	0 (-)	14.0 (126)
KAH2502	2025	653 (13)	6 (64)	14.9 (75)	11.4 (47)	173.8 (50)

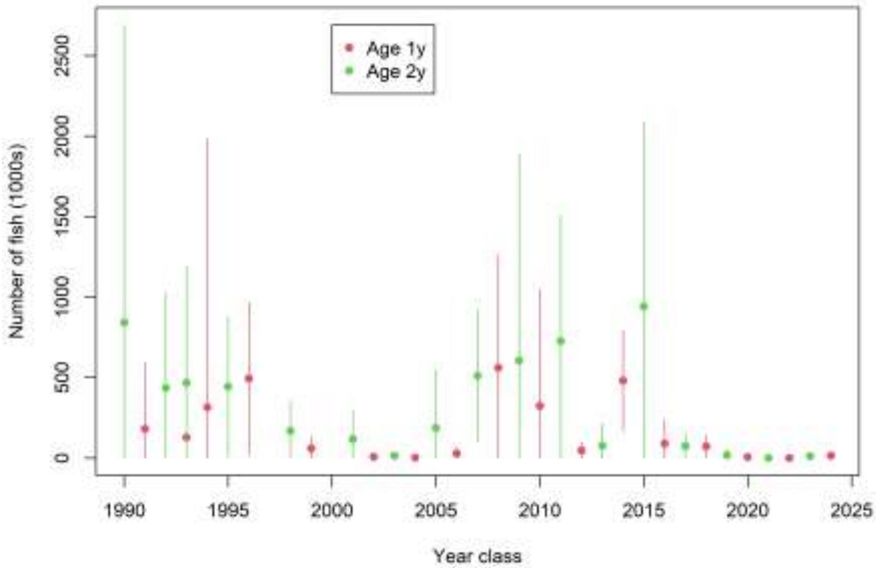

Figure 29: Tarakihi age 1 year and 2 year abundance indices (and associated 95% confidence intervals) derived from the Tasman Bay and Golden Bay area of the Kaharoa inshore trawl surveys.

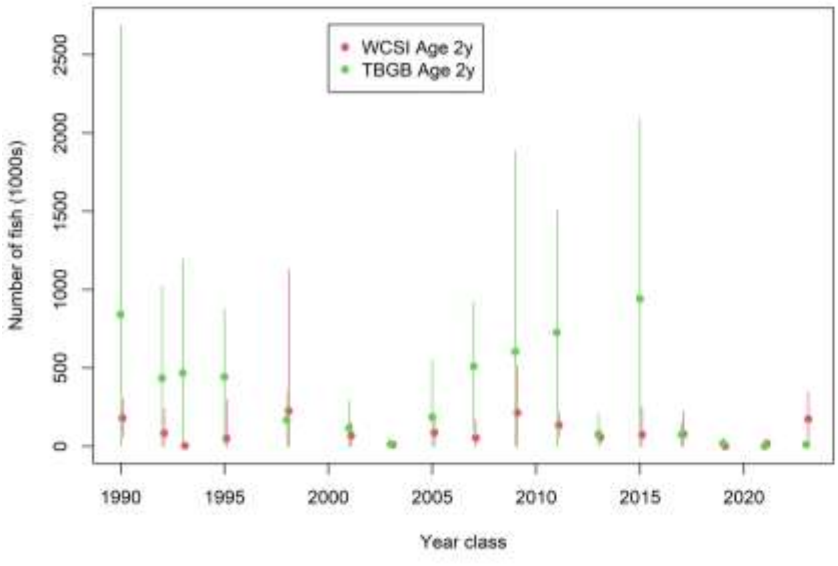

Figure 30: Tarakihi age 2 year abundance indices (and associated 95% confidence intervals) derived from the Tasman Bay and Golden Bay (TBGB) and west coast South Island (WCSI) areas of the Kaharoa inshore trawl surveys.

Aged otolith sets were available from the 13 trawl surveys between 2000 and 2025. For each survey, sex specific age-length keys (ALK) were derived from the otoliths collected from the WCSI sub area. The ALKs were applied to the WCSI scaled length compositions to determine survey age compositions (Appendix 4). There is clear progression of individual year classes through successive (usually biennial) surveys (Figure 31).

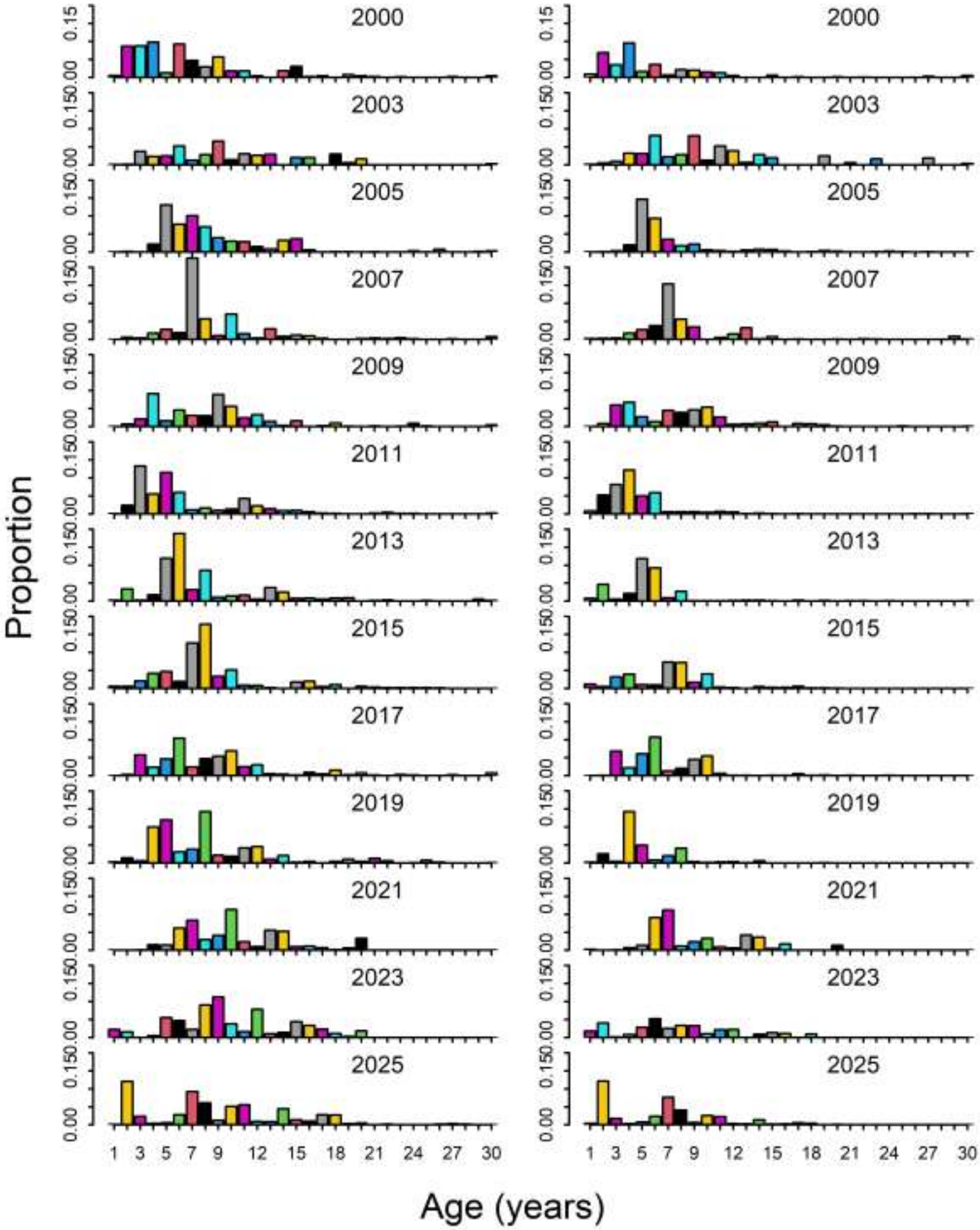

Figure 31: Female (left) and male (right) age compositions from the WCSI trawl surveys. The 30 y age class is an accumulation of fish 30 y and older ("plus group"). The individual year classes are assigned a specific colour to track individual year classes over successive surveys.

For the WCSI trawl survey, female fish account for a higher proportion of the fish older than about 7 years. The time series of WCSI trawl survey length sampling data were analysed to investigate the differential in sex ratio for older fish. For each survey trawl sampled, the sex ratio of tarakihi larger than 30 cm (FL) was determined. The sex ratio differed with the depth of the trawl; trawls shallower than 200 m were dominated by female fish, whereas trawls deeper than 200 m were dominated by males (Figure 32). This indicates a sex specific partitioning of the population by depth during the spawning season that may result in a lower availability of male fish to the survey relative to females.

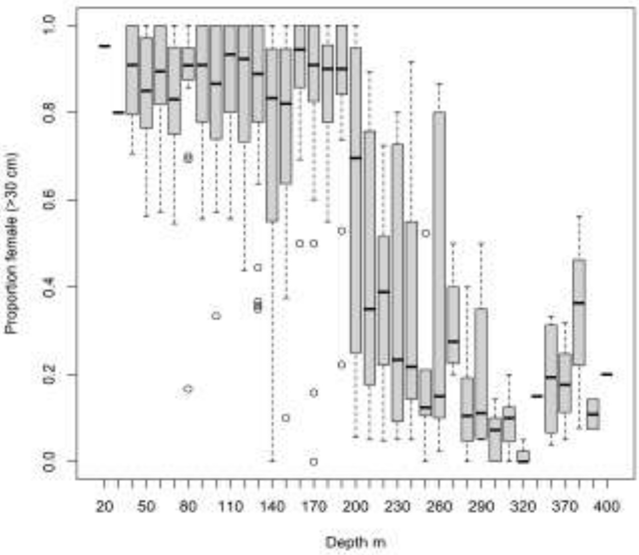

Figure 32: Relationship between trawl depth (m) and the proportion of female tarakihi greater than 30 cm (FL) from individual WCSI trawl stations from the entire time series of *Kaharoa* inshore trawl surveys.

Trawl surveys of inshore finfish species off the west coast of the North Island were first conducted by R.V. *Kaharoa* in October-November 1986 and 1987. The spatial extent of these initial surveys was relatively limited and did not encompass the broader distribution of tarakihi. The survey area was extended for the subsequent series of trawl surveys that were conducted in 1989 (Drury & McKenzie 1992), 1991 (Drury & Hartill 1992), 1994 (Langley 1995), 1996 (Morrison 1998) and 1999 (Morrison & Parkinson 2001). The *Kaharoa* trawl surveys were reinstated with four surveys in October-November 2018, 2019, 2020 and 2022 (Jones et al. 2022, Jones et al. 2024).

Since 1991, most surveys have encompassed a core area (from Ninety Mile Beach to North Taranaki Bight extending seaward to the 200 m depth contour) and utilised a similar spatial stratification. The spatial domain of the core area was refined to account for the removal of the Māui dolphin trawl exclusion area (introduced in 2008) which was not sampled by the 2018 and 2019 trawl surveys. The Māui dolphin trawl exclusion area was extended in October 2020, further limiting the extent of the shallower, inshore areas sampled by the 2020 and 2022 trawl surveys (Jones et al. 2022, Jones et al. 2024).

A core survey area, excluding the full extent of the Māui dolphin trawl exclusion area, was defined to derive a comparable time series of survey tarakihi biomass indices and scaled length compositions. The core area approximated the area of FMA 9 (TAR 1W) inside the 200 m depth contour. A total of seven surveys encompassed the core area.

The first three surveys provide comparable biomass indices for tarakihi, although the 1991 index is highly uncertain (Table 9 and Figure 33). There was a hiatus of 18 years before the next set of surveys. The more recent biomass indices are more variable; the 2018 survey is highly uncertain, while the 2019 and 2020 surveys yielded comparable biomass indices that are somewhat lower than the indices from the earlier period. The 2022 survey index was substantially lower than the two preceding indices (Figure 33).

Table 9: Tarakihi biomass (t) indices (and CV %) for the time series of FMA 9 *Kaharoa* WCNI surveys.

Survey	Year	Model Year	Biomass (t)	CV (%)
KAH9111	1991	1992	418	56
KAH9615	1996	1997	487	33
KAH9915	1999	2000	423	16
KAH1806	2018	2019	462	45
KAH1906	2019	2020	282	18
KAH2005	2020	2021	340	21
KAH2205	2022	2023	113	33

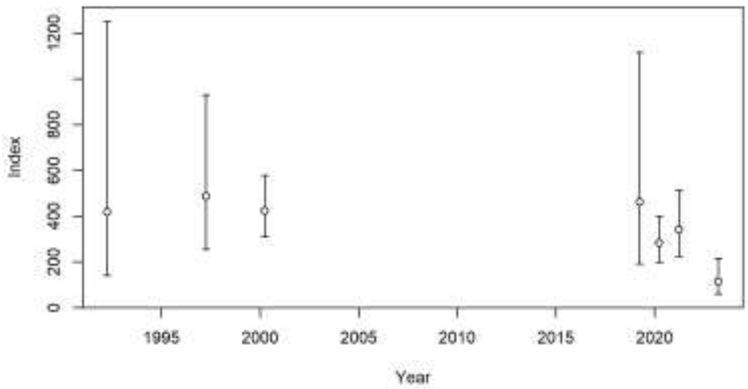

Figure 33: Tarakihi biomass (t) indices (and 95% confidence intervals) for the time series of FMA 9 *Kaharoa* WCNI surveys.

Tarakihi otoliths were collected from the four most recent surveys. The Ninety Mile Beach strata typically accounted for a considerable proportion of the total survey biomass for tarakihi. The otoliths collected from within the Ninety Mile Beach strata (A100 and A200) were selected for age determination. There were a limited number of tarakihi otoliths available from the four surveys and all otoliths collected from the two strata were aged (a total of 410 fish).

The ageing data were used to construct survey specific age-length keys for male and female fish. The resultant age-length keys were applied to the scaled survey length compositions to derive age compositions for the four most recent surveys. The age compositions included a "plus group" for fish aged 30 years and older (Appendix 4).

6.3 Commercial fisheries age compositions

Limited sets of age compositions are available from the three main western tarakihi fisheries (Table 10). Data were compiled as sex specific proportional age compositions with a "plus group" for fish aged 30 years and older (Appendix 4). Commercial age composition data from the WCSI fishery for 2005 and 2007 (Manning et al. 2008) were re-aged for this project using the revised tarakihi ageing protocol (Walsh et al. 2016).

Table 10: A summary of the age compositions available from the western tarakihi commercial fisheries.

Fishery	Fishing years	Source
WCNI (TAR1W)	2014, 2015	McKenzie et al. 2017
	2019, 2020	McKenzie et al. 2021
	2024, 2025	McKenzie et al. 2026
TAR 8	2019, 2020	McKenzie et al. 2021
	2024, 2025	McKenzie et al. 2026
WCSI (TAR7W)	2005, 2007	Manning et al. 2008 re-aged for this project.
	2019, 2020	McKenzie et al. 2021
	2024, 2025	McKenzie et al. 2026

The age composition data sets from the commercial fisheries were compared with the age composition data from the WCSI and WCNI trawl surveys (Figure 34). For this purpose, the annual age compositions were summarised by combining both sexes and aggregating the data for fish aged 15 years and older.

The relative strength of individual year classes is broadly comparable amongst the sets of survey and fishery age compositions (Figure 34). For example, the strong 2015 and 2014 year classes observed in the WCSI trawl survey as 4 and 5 year old fish in 2019 were also evident in the TAR 8 fishery age compositions in 2018–19 and 2019–20. Those year classes persisted in the WCSI survey and TAR 8 age compositions from later years. Further, those year classes became increasingly dominant in the age compositions from both the WCSI and WCNI fisheries and the WCNI trawl surveys (Figure 34).

The TAR 8 fishery age compositions from 2018–19 and 2019–20 were composed of a higher proportion of younger (5 and 6 year) tarakihi than the age compositions from 2023–24 and 2024–25 (Figure 34). Correspondingly, the earlier samples were composed of a lower proportion of older (15+ year) fish. An examination of the catch and effort records from the sampled fishing trips revealed that most of the tarakihi catches sampled during 2018–19 and 2019–20 were from shallower trawls (less than 100 m) that were primarily targeting red gurnard, whereas the tarakihi catches sampled in 2023–24 and 2024–25 were from deeper (120–160 m) trawls targeting tarakihi. There was limited overlap in the spatial distribution of the tarakihi catch sampled from the two projects.

Preliminary assessment models were unable to simultaneously fit the TAR 8 age composition data from the two time periods using a single selectivity function. Most of the annual catch from TAR 8 has been taken from the target tarakihi fishery and, on that basis, the age composition data from 2023–24 and 2024–25 were assumed to be more representative of the total catch from the TAR 8 fishery. The earlier data were considered to provide some additional information regarding year class strengths and were retained in the assessment model to inform recruitment estimates. Those data were partitioned from the fishery data and configured as a “survey” age composition with a separate selectivity function.

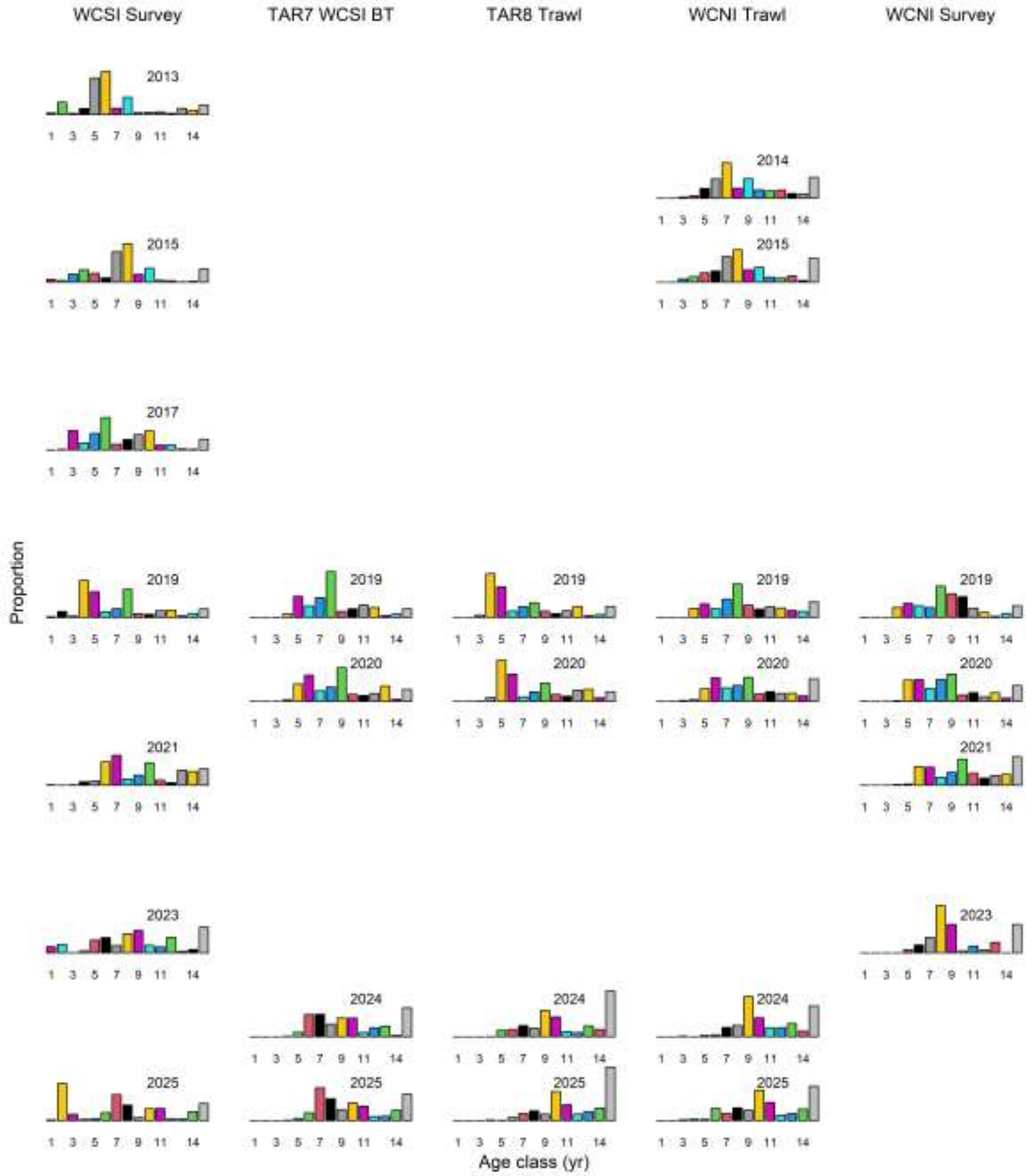

Figure 34: A comparison of the age compositions from the three commercial fisheries (TAR7 WCSI BT, TAR 8 trawl and WCNI trawl) and the WCSI and WCNI trawl surveys. For presentation purposes, both sexes were combined and fish aged 15 years and older were aggregated in a "plus group". Individual year classes were assigned a specific colour while the "plus group" is coloured grey. Age compositions from the WCSI trawl survey from the years before 2013 are not shown.

7. STOCK ASSESSMENT

The assessment was based on the hypothesis of a single west coast stock of tarakihi encompassing the west coast of the South Island (western portion of TAR 7), Tasman Bay & Golden Bay (within TAR 7), the west coast of the North Island (TAR 8 and western portion of TAR 1).

The assessment was conducted using an integrated age structured population model implemented in Stock Synthesis (version V3.30.23.1), a flexible platform for implementing statistical, age structured population models (Methot & Wetzell 2013, Methot et al. 2020). The assessment model(s) incorporated the available catch, CPUE indices, trawl survey biomass estimates and age frequency distributions, and commercial age composition data.

7.1 Model development

The initial phase of the modelling evaluated an alternative range of spatial configurations to investigate the population structure of western tarakihi. The basic spatial units of the models were defined by the structure of the core data sets; i.e. WCSI, TBGB, TAR 8 and WCNI.

An initial model was configured that included the WCSI and TBGB areas only. These areas include the most comprehensive sets of abundance indices (WCSI trawl surveys and CPUE) and age compositions (WCSI trawl surveys and commercial) and juvenile abundance indices (primarily TBGB trawl surveys). The spatial domain of the models was progressively extended with the stepwise inclusion of the TAR 8 and WCNI areas within the model structure, initially modelled as a single population with separate fisheries ("Fisheries As Areas" approach).

An increasingly complex set of spatially structured models were configured, including two or three model regions and associated movement parameters. Differential trends in the abundance indices were accommodated via temporal variation in the estimation of the movement parameters and/or by estimating regional variation in recruitments. These approaches considerably increased the total number of estimated parameters, while the overall improvements in the model likelihood functions were relatively small. Further, the changes in model structure did not appreciably change the overall model results in terms of the overall stock size and the estimates of current stock status. Thus, the most parsimonious approach was to adopt the entire western stock, single region model ("Fisheries As Areas") as the primary stock assessment model.

None of the initial model options provided an adequate fit to the TAR 8 CPUE indices. The general increase in the TAR 8 CPUE indices during 2018–2024 contradicts the recent decline in the WCSI trawl survey (and CPUE) and the longer-term decline in the WCNI CPUE indices (Section 3). The TAR 8 CPUE indices were derived from a number of composite target fisheries delineated by depth (predominantly tarakihi and red gurnard target trawls). The individual fisheries exhibit different trends in catch rates and are likely to catch a different component of the population; the tarakihi bycatch from the shallower red gurnard target trawl fishery is likely to be composed of younger fish compared to the catch from the deeper tarakihi target trawl fishery. The proportion of records from the two main constituent fisheries changed considerably over the time period. The resultant CPUE indices may not adequately account for the complex structure of the fishery and are considered less reliable than the other abundance indices. On that basis, the TAR 8 CPUE indices were excluded from the final model options.

The *Kaharoa* WCSI trawl surveys also provide estimates of the relative abundance of fish aged 1 (1+) and 2 (2+) years from the Tasman Bay and Golden Bay area. Both sets of indices indicate a low abundance of juvenile tarakihi corresponding to the 2016–2023 year classes.

In addition, the trawl survey also provided estimates of the relative abundance of 2 year old fish from the WCSI area of the survey, while 1 year old fish were negligible from that area of the survey. In general, 2 year old fish were less abundant in the WCSI area compared to TBGB, although the relative trends were similar between the two areas. The exception was the most recent survey (2025) which estimated a higher abundance of 2 year old fish from the WCSI area and a very low abundance from TBGB.

The difference in overall scale of the 2 y indices between the two areas means that simply combining the indices may not produce a reliable index of abundance, particularly if availability was lower for the WCSI portion of the survey. For the final model options, both sets of 2 year old indices were excluded, while the TBGB 1 year indices were retained.

There is considerable uncertainty regarding the magnitude of catch from the early period of the fishery. A range of contrasting model options was investigated that compared the models initialised in 1932 (under unexploited equilibrium conditions) with models that commenced in 1975 and estimated the initial level of depletion. There was considerably more uncertainty associated with the level of biomass in the late 1970s from the models initialised in 1975. However, the biomass trajectories from the two sets of models converged during the 1980s and the estimates of current stock status were very similar from the two sets of models. This indicates that the estimate of overall recruitment (R_0) and hence SB_0 is informed by the main sets of data observations (from 1990–2020) rather than the historical catch data.

7.2 Model structure

The assessment domain of western tarakihi was configured as a single region encompassing the four commercial fisheries (based on QMAs). The model population was initialized in 1932 in an equilibrium, unexploited state. The population structure was partitioned by sex and included 40 age classes, and the oldest age class represented an aggregated ‘plus’ group (40 years and older). The model data period extended to the 2025 year (the 2024–25 fishing year).

The key biological parameters are presented in Table 11. For both sexes, natural mortality (M) was specified as a constant value of 0.10. This estimate of M is based on an analysis of the age structure of a lightly exploited tarakihi population sampled off the west coast of the South Island in 1971 and 1972 (Vooren 1977).

The derivation of the growth parameters from the WCSI trawl survey age data is described in Section 5.1. These data were also used to derive the age specific maturity of female tarakihi (Section 5.2) (Table 11).

Table 11: Biological parameters for the base assessment model.

Parameter	Value
Natural mortality	0.10 y^{-1}
Growth parameters	Males *L1* 12.57 cm, *L40* 42.94 cm, *k* 0.162, *b* 1.88
(Schnute)	Females *L1* 12.63 cm, *L40* 45.85 cm, *k* 0.142, *b* 1.87
Length-wt	*a* 1.432e-05, *b* 3.068
Proportion mature	Age based
	Ages 1–9 0.00, 0.03, 0.06, 0.14, 0.27, 0.47, 0.68, 0.84, 0.92
	Ages 10+, 1.0
SRR steepness	*h* 0.8
SigmaR	σR 0.6

The annual time step was divided into two periods (October-March and April-September), partitioning the commercial catch and the main spawning period (season 2). Spawning is assumed to occur instantaneously at the start of the second period. A Beverton-Holt spawning stock recruitment relationship (SRR) was assumed with a fixed value of steepness (h) of 0.8. The main recruitment deviates (1985–2024) from the SRR were estimated assuming a standard deviation of the natural logarithm of recruitment (σR) of 0.6. There was no averaging constraint applied to the recruitment deviates (i.e. estimated as simple independent deviates).

The model was configured to include a recreational fishery and four commercial trawl fisheries: WCSI (TAR 7W), TBGB (TAR 7W), TAR 8 and WCNI (TAR 1W). The compilation of the catch history for each fishery is described in Section 6.1. The commercial catches included an additional allowance for unreported catch: an additional 20% per annum for the years prior to the introduction of the QMS (in 1986–87) and 10% per annum in the subsequent years.

The main input data sets included in the assessment model are as follows:

- Fishery specific annual catches 1932–2025 (2025 = 2024–25 fishing year), including recreational catches (Appendix 4, Table A16).
- *Kaharoa* inshore WCSI trawl survey biomass estimates (excluding TBGB) (n = 17) and associated age compositions (n = 13) (Table 12 and Table 13).
- *Kaharoa* inshore TBGB trawl survey Age 1 year recruitment indices (n = 17).
- CPUE indices from the WCNI trawl fishery (1994–2025) (Appendix 4, Table A5).
- *Kaharoa* inshore WCNI trawl survey biomass estimates (n = 7) and associated age compositions (n = 4) (Table 12 and Table 13).
- Commercial age composition data: WCSI-BT (n = 6), TAR8-BT (n = 4), and WCNI-BT (n = 6) (Table 13).

The age composition of the catch from each fishery is mediated by the age-based selectivity of the individual fisheries. For the main fisheries (WCSI, TAR 8 and WCNI), the age compositions of the catches were comparable and the oldest age classes were assumed to be fully vulnerable (logistic selectivity). Two of the age samples from the TAR 8 fishery were composed of younger fish and the observations were not considered to fully represent the older age classes. These observations were treated as a separate "survey" and the selectivity was parameterised using a double normal function, allowing for lower vulnerability of the older age classes. The WCNI CPUE indices shared the selectivity function of the associated fishery. The WCSI CPUE indices were not included in the base model as it was considered that the WCSI trawl survey provided a more reliable index of stock abundance for the area.

The catches from the TBGB fishery prior to 1985 were considerably higher than the catches from the subsequent period. The earlier catches were assigned to the fishery based on port of landing. It is likely that those larger catches were taken from the WCSI area and landed in Nelson. On that basis, the selectivity of the TBGB fishery was assumed to be equivalent to the WCSI fishery.

There is close correspondence between the age compositions from the WCNI trawl survey and the WCNI commercial fishery. Nonetheless, the selectivity of the WCNI trawl survey was parameterised with a separate logistic function.

For the WCSI trawl survey, there is a strong increase in the proportion of female fish in the age compositions from about age 7 years and female fish dominate the age composition from about 10 years. This shift in the sex ratio corresponds with the maturity ogive for female tarakihi, with 50% maturity at about 6 years and full maturity from 10 years of age. Sex specific selectivity functions were estimated to account for the lower proportion of male fish in the older age classes. The selectivity of female fish was estimated using a double normal function with the selectivity of oldest year classes constrained to full selectivity. Male selectivity was estimated relative to females, with selectivity varying from the age of full selectivity to the terminal age.

The age 1 year TBGB survey indices were incorporated in the model with age-specific selectivity (full selectivity for 1 year old fish only) and an estimated catchability coefficient. Initial fits revealed that the models were unable to account for the magnitude of the variation in the indices. This may indicate a density dependent process in the availability of the juvenile (1 y) tarakihi to the trawl survey. Model options were investigated to estimate a non-linear relationship between the indices and overall age 1 abundance by estimating an additional power parameter (exponent) associated with the catchability coefficient. However, the data were not sufficiently informative to simultaneously estimate the two catchability parameters due to the high uncertainty associated with the indices. The additional catchability parameter was excluded from the final model.

Limited age composition data were available from most fisheries and the Effective Sample Size (ESS) was fixed at a relatively high value (of 20) to ensure that the data informed the estimation of the selectivity functions. For the WCSI trawl survey age compositions, the individual observations were assigned an initial ESS based on the MWCV of the age compositions (Table 13). The final ESS was derived via reweighting of the data based on Method TA1.8 of Francis (2011). The data weighting procedure also assigned an additional process error (0.1) to the CV of the WCNI CPUE indices (Table 12).

Table 12: Summary of abundance indices included in the Base Case assessment model with the associated coefficient of variation (CV) and additional process error associated with each data set.

Survey/Fishery	Model years	CV
Trawl survey WCSI	1992–2025 (n=17)	0.13–0.28
Trawl survey TBGB 1Y	1992–2025 (n=17)	0.33–2.68
Trawl survey WCNI	1992, 1997, 2000, 2019, 2020, 2021, 2023	0.16–0.56
Commercial WCNI	1994–2025 (n=32)	0.16–0.24 + 0.1

Table 13: Summary of age composition data included in the Base Case assessment model with the associated Effective Sample Size (ESS) for the individual data sets.

Survey/Fishery	Model years	ESS
Trawl survey WCSI	2000, 2003, 2005, 2007, 2009, 2011, 2013, 2015, 2017, 2019, 2021, 2023, 2025	9–16.2
Trawl survey WCNI	2019, 2020, 2021, 2023	20
Commercial WCSI	2005, 2007, 2019, 2020, 2024, 2025	20
Commercial WCNI	2014, 2015, 2019, 2020, 2024, 2025	20
Commercial TAR 8	2019, 2020 (“survey”)	20
	2024, 2025 (“fishery”)	20

The model likelihood objective function included the following components:

i. The fit to the abundance indices (WCSI survey biomass, WCNI survey biomass and WCNI CPUE indices) assuming a lognormal error structure.
ii. The fit to the trawl survey 1 y abundance indices (lognormal error structure).
iii. The fit to the trawl survey and fishery age composition data assuming a multinomial error structure.
iv. Recruitment deviations. The formulation of the likelihood constrains recruitment deviations relative to the (assumed) standard deviation (*sigmaR*).
v. Parameter priors. Deviation of estimated parameter(s) from assumed prior distribution(s).

The formulation of the individual likelihood components is documented by Methot & Wetzell (2013).

The estimation procedure minimises the negative log-likelihood of the objective function. Model uncertainty was determined using MCMCs implemented using the Metropolis-Hastings algorithm. For each model option, 1000 MCMC samples were drawn at 1000 intervals from a chain of 1.1 million following an initial burn-in of 100 000. The performance of the MCMC sample was evaluated using a range of diagnostics.

7.3 Parameter estimates

The selectivity of the commercial fishery will be influenced, in part, by the commercial Minimum Legal Size (MLS) of 25 cm (FL) for tarakihi. The selectivities of the commercial fisheries were assumed to be logistic. The resulting estimates of selectivity were similar for the three main commercial fisheries (WCSI, TAR 8 and WCNI), although the WCSI fishery is estimated to have a higher selectivity for younger fish (5–6 y) fish compared to the other two fisheries (Figure 35).

The selectivity for female fish from the WCSI area of the *Kaharoa* trawl survey has a higher selectivity for 4–5 year old fish compared to the WCSI fishery (Figure 35), although the survey selectivity for 1–3 year old fish is low indicating a low availability of juvenile fish for the WCSI portion of the survey. The survey selectivity of male fish declines considerably for fish older than 6 years and is estimated to be low for fish older than 20 years (Figure 35).

The selectivity for the WCNI trawl survey closely approximates the WCNI fishery, with 50% selectivity at about 5 years of age and full selectivity at about 7 years (Figure 35).

The TAR 8 "survey" selectivity was estimated to fit the age compositions sampled in 2018–19 and 2019–20 separately from the more recent years (2023–24 and 2024–25). The earlier age compositions were primarily taken from sampling of tarakihi catches taken in shallower trawls targeting red gurnard. The "survey" is estimated to fully select fish from 4 years of age and have a lower selectivity for fish older than 25 years (Figure 35). This contrasts with the TAR 8 fishery selectivity (primarily derived from target tarakihi sampled catches) which has full selectivity from 8 years of age (Figure 35).

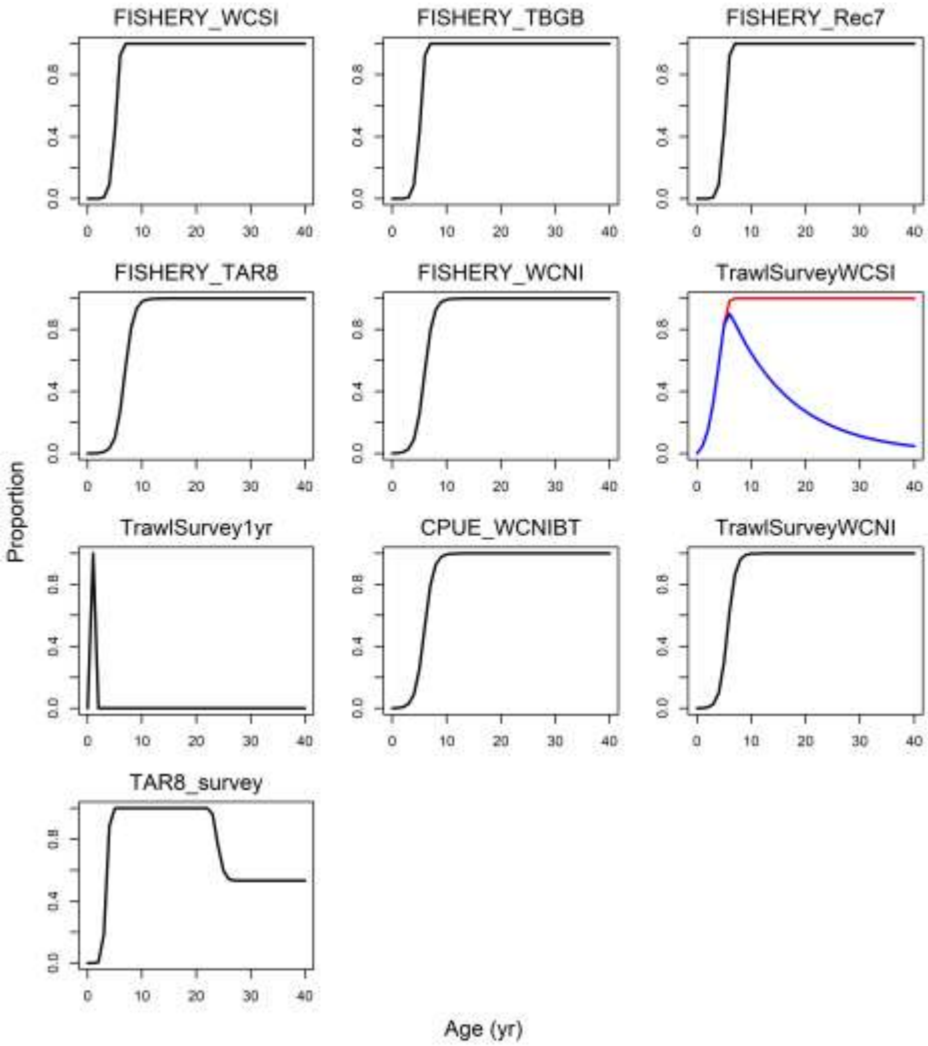

Figure 35: Age specific selectivity functions for commercial fisheries and surveys. The black lines represent a combined selectivity for both sexes, while red and blue lines for the WCSI trawl survey are for female and male fish, respectively.

For the base model, a likelihood profile was conducted for the overall population scale parameter (R_0) (Figure 36). The lower bound of the estimate of R_0 is primarily determined by the cumulative catch in conjunction with the variation in recruitment deviates (informed by the *sigmaR* parameter). The upper bound of the estimate of R_0 is informed by the various sets of abundance indices and age composition data. These data all indicate that there is a low probability of a substantially higher overall biomass, given the associated model assumptions (particularly *M* and the logistic fishery/survey selectivity functions) (Figure 36).

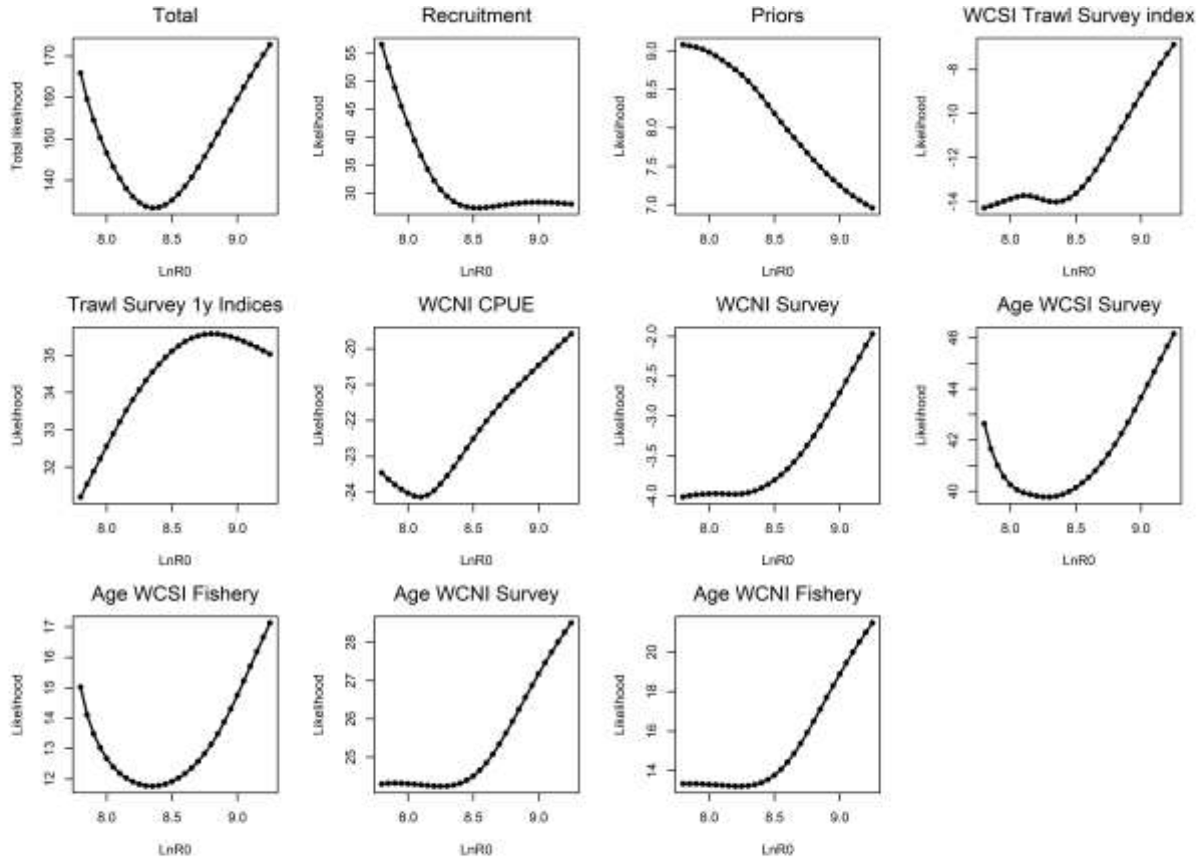

Figure 36: Likelihood profiles for the recruitment parameter R_0 for all likelihood components combined (total) and the individual components of the likelihood.

Recruitment deviates were estimated from the SRR were estimated for 1985–2024. Recruitments were estimated to be above average during 1994–2000 and below average during 2001–2004 (Figure 37). Annual recruitments were more variable during 2005–2015 with strong recruitments every 2–3 years. Recruitments were estimated to be well below average during 2016–2022, with an exceptionally low recruitment deviate estimated for 2022 (Figure 37).

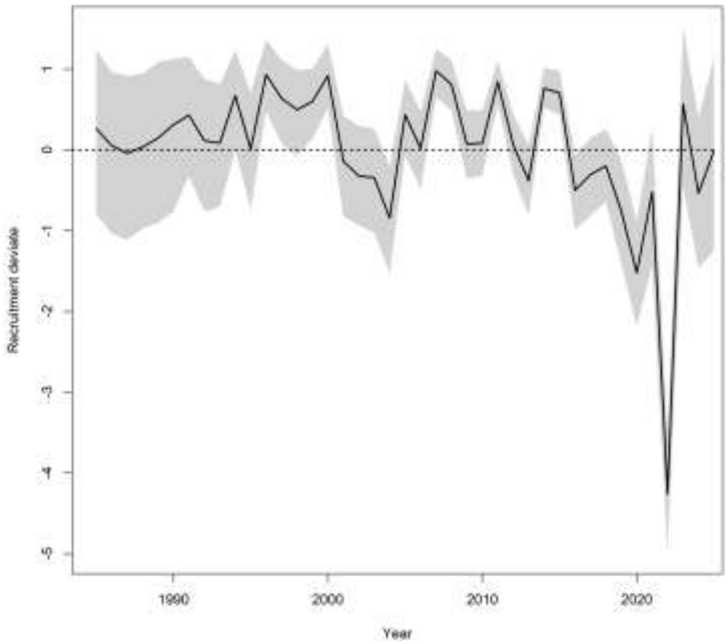

Figure 37: Annual recruitment deviates (median values) and 95% confidence intervals derived from MCMCs. The black line represents the median of the MCMC estimates and the shaded error represents the 95% confidence interval.

7.4 Diagnostics

The model provides a reasonable fit to the WCSI trawl survey and WCNI CPUE indices from 2005 onwards (Figure 38). However, there are divergent trends in the two sets of abundance indices during 1999–2004 and the model simply mediates the abundance trend from the two sets of indices. The model over-estimates the three trawl survey biomass indices from 1997, 2000 and 2003, while under-estimating the WCNI CPUE indices from 1999–2005 (Figure 38). The 2005 trawl survey biomass index appears to be an outlier based on the change in the spatial distribution of tarakihi for the survey. The 2017 biomass index is also underestimated by the model. The 1994 WCNI CPUE index was substantially lower than the indices for the subsequent years and the low value was not fitted by the model (Figure 38). It is likely that the index was biased low due to incomplete data during the transition to a new reporting format for catch and effort data.

The model provides a good fit to the WCNI trawl survey biomass indices, except for the very low biomass index for the final observation (2023 model year) (Figure 38).

The model estimates of lower and higher recruitments tend to correspond with the TBGB trawl survey recruitment indices (Figure 38). However, the overall fit to the indices is poor as the model substantially under-estimates the magnitude of the larger indices. The poor fit to the indices reflects the low precision of the indices (average CV of 85%).

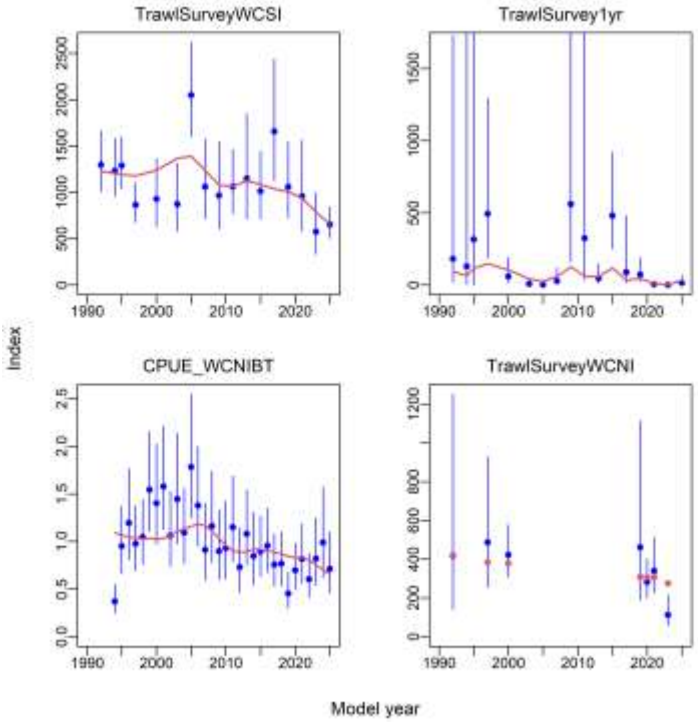

Figure 38: The observed abundance indices (blue points) and predicted values (red lines or points) from the base stock assessment model.

Overall, the model provides a good fit to the age composition data from the fisheries and WCSI and WCNI trawl surveys (Figure 39 to Figure 44). However, there are some notable exceptions. The fits to the recent (2021, 2023 and 2025) WCSI survey age compositions are considerably worse than earlier years, particularly for the younger (1–5 y) age classes (Figure 39 and Figure 40). For 2021, the model over-estimated the proportion of younger fish in the age compositions. For 2023, there was a higher proportion of 2 year old fish in the age compositions, this informed the model estimate of the 2021 year class, although the year class was virtually absent as age 4 y fish in the 2025 survey age composition (Figure 39).

In contrast, the model estimated an extremely weak 2022 year class that is consistent with the virtual absence of 1 y old fish from the 2023 TBGB recruitment index. However, the year class is observed as 1 and 3 year old fish in the 2023 and 2025 WCSI survey age compositions, respectively (Figure 39).

The model has a single observation of the 2023 year class at age 2 y in the 2025 WCSI survey age composition. The year class is estimated to be stronger than average, although the model substantially under-estimates the proportion of 2 y fish in WCSI survey age composition (Figure 39). This year class was the strongest observed as 2 y fish from the WCSI recruitment index, but virtually absent from the TBGB 2 y recruitment index (not fitted). The relative strength of the 2023 recruitment estimate is constrained by the recruitment component of the likelihood and the relative weighting (ESS) of the single age observation.

The model under-estimated the strength of the 2011 year class in the WCSI survey female age compositions (at 8 y in 2019, 10 y in 2021 and 12 y in 2023) (Figure 39 and Figure 40). The 2011 year class was also underestimated in the 2019 (8 y) and 2020 (9 y) WCSI fishery male and female age compositions (Figure 41) and 2019 (8 y) WCNI fishery male age composition (Figure 43).

For the TAR 8 fishery, the sex ratio of fish in the 7–14 y age classes is skewed to male fish. The model assumes an equivalent selectivity for male and female fish. Consequently, the proportion of female fish in those age classes is over-estimated by the model (Figure 42).

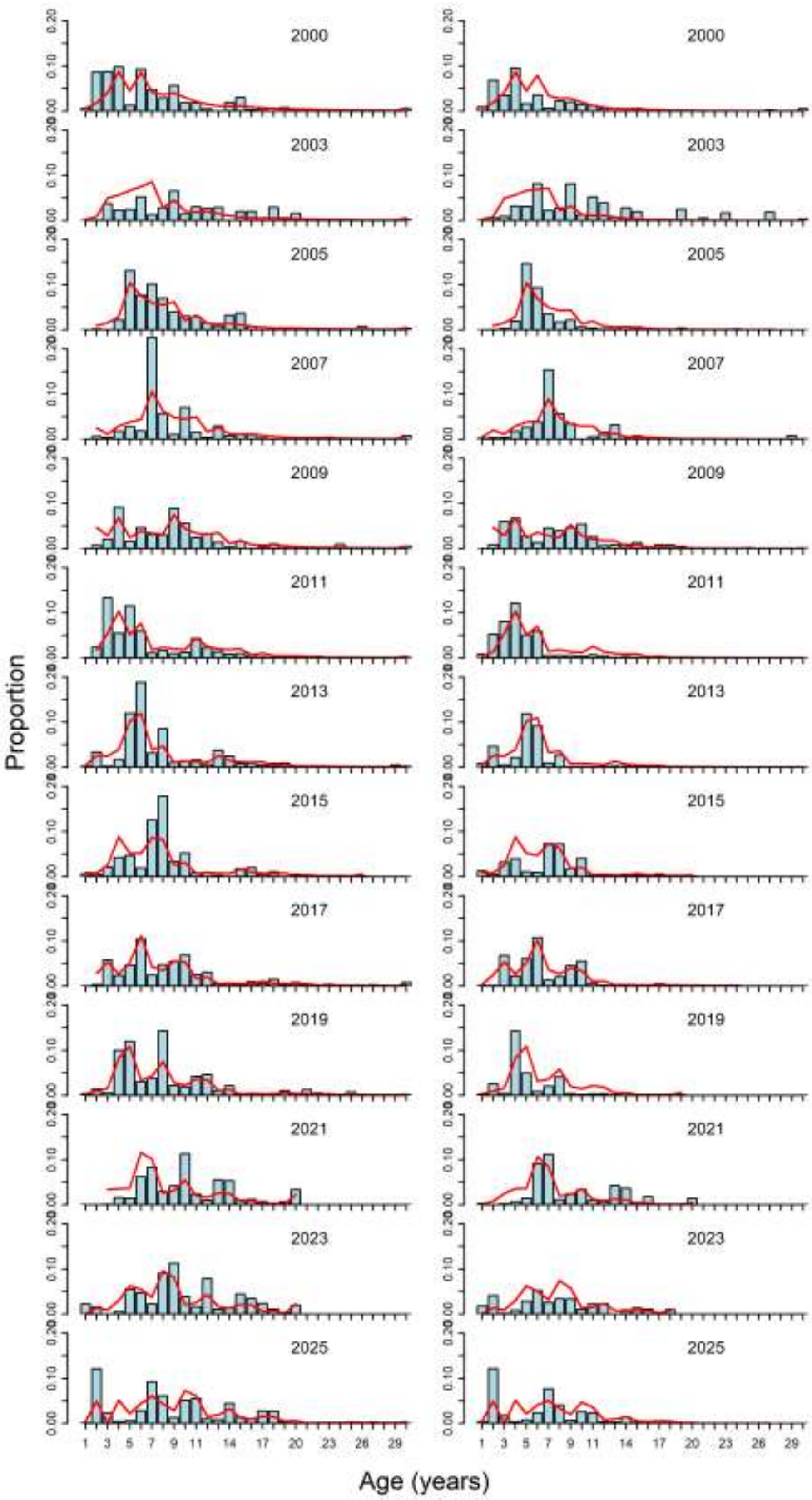

Figure 39: Observed (bars) and predicted (red lines) proportions at age for female (left) and male (right) age compositions from the *Kaharoa* WCSI trawl surveys.

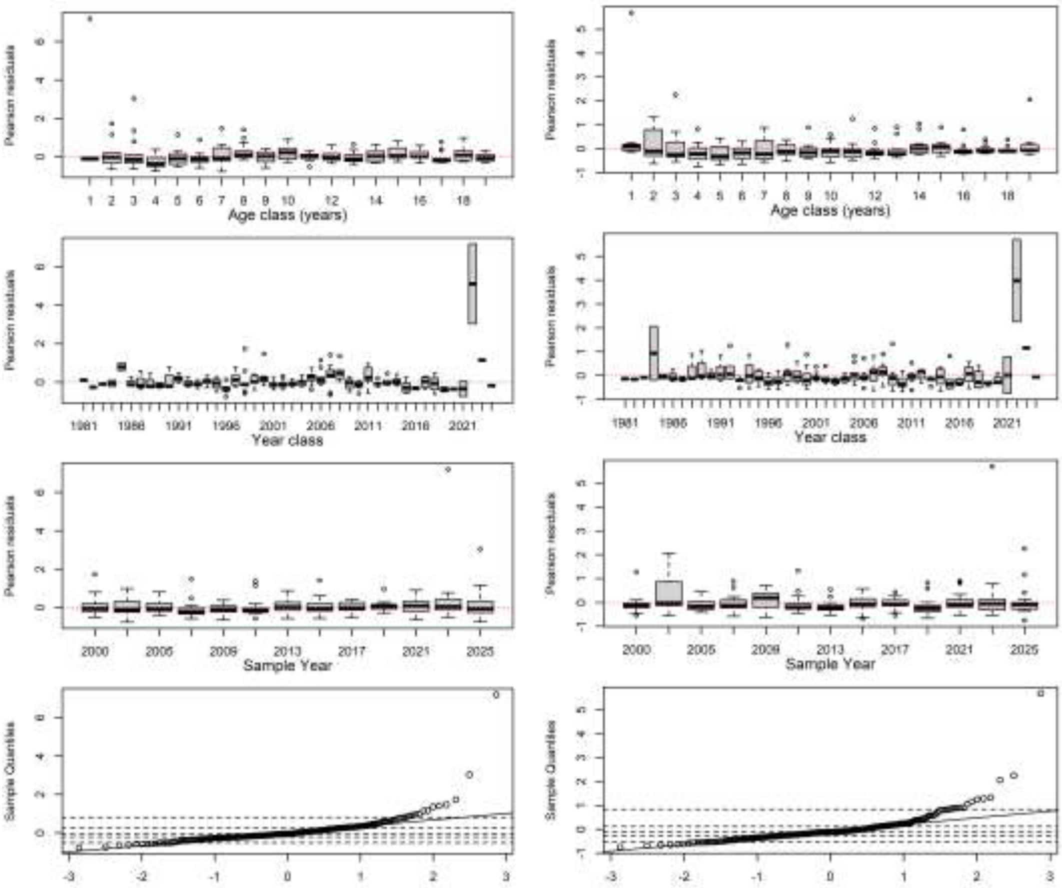

Figure 40: Residuals for the model fits to the proportions at age for female (left) and male (right) age compositions from the *Kaharoa* WCSI trawl surveys by age class, year class and sample year. The quantile plots for the distributions of the residuals are also presented (lower panels).

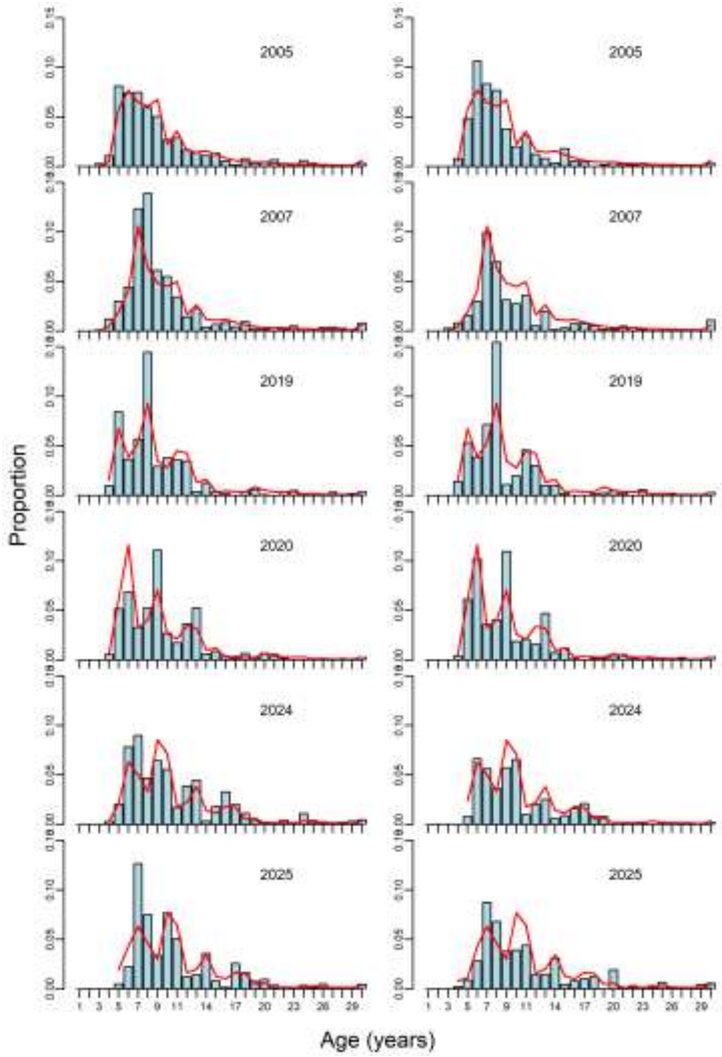

Figure 41: Observed (bars) and predicted (red lines) proportions at age for female (left) and male (right) age compositions from the WCSI commercial fishery.

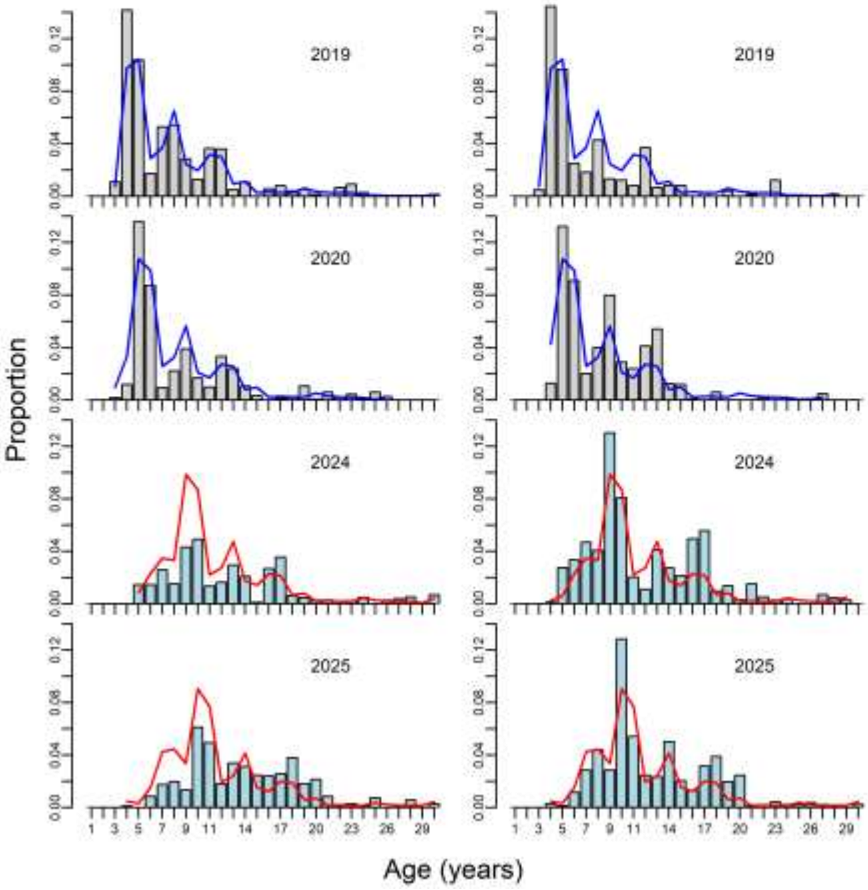

Figure 42: Observed (bars) and predicted (lines) proportions at age for female (left) and male (right) age compositions from the TAR 8 commercial fishery. The 2019 and 2020 age compositions were fitted with a separate "survey" selectivity.

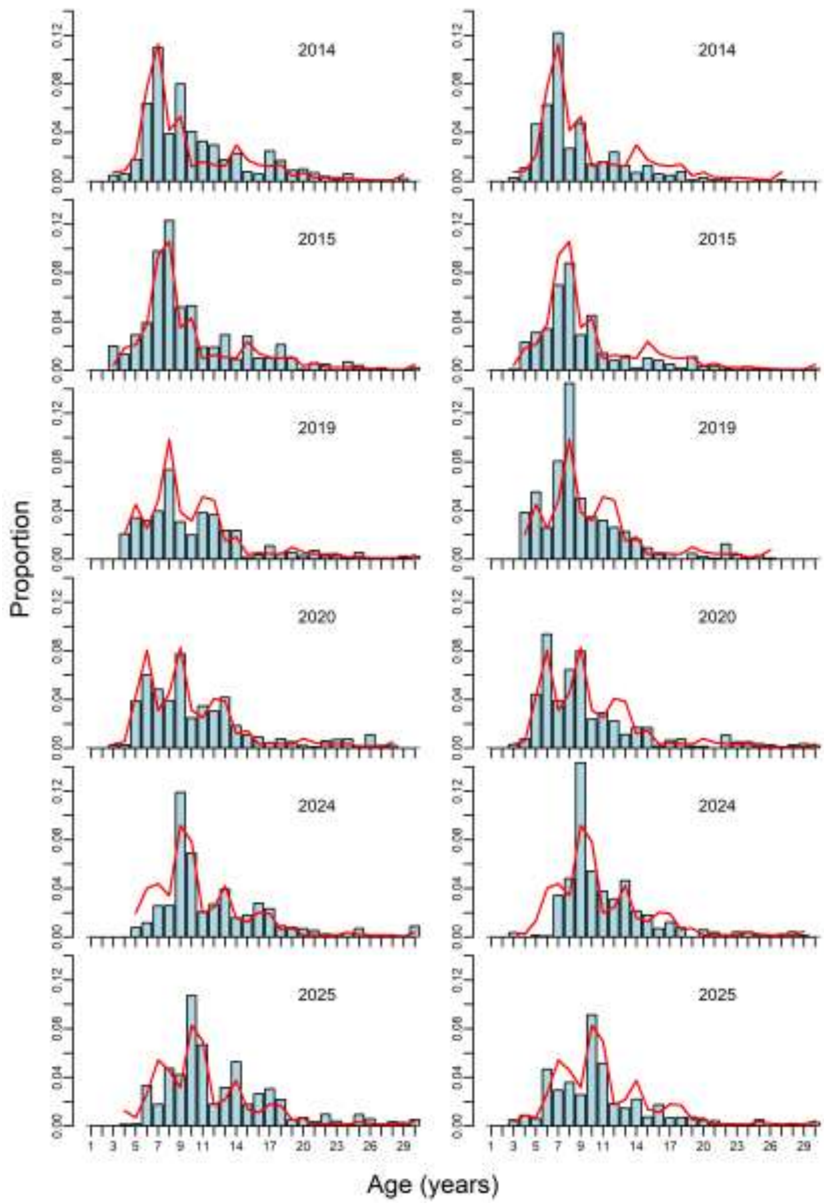

Figure 43: Observed (bars) and predicted (red lines) proportions at age for female (left) and male (right) age compositions from the WCNI commercial fishery.

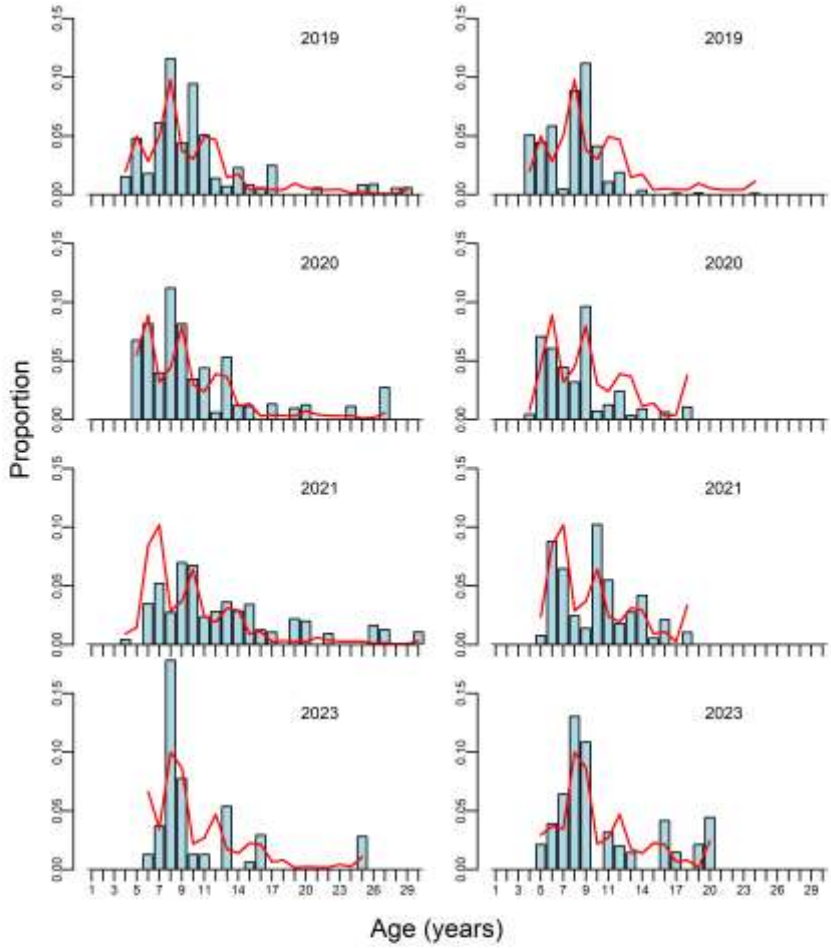

Figure 44: Observed (bars) and predicted (red lines) proportions at age for female (left) and male (right) age compositions from the WCNI trawl survey.

7.5 Model dynamics

Spawning biomass is estimated to have declined considerably during the 1960s and 1970s following the development of the fishery (Figure 45). Over the subsequent years, spawning biomass continued to decline at a lower rate until 2020. From 2020, spawning biomass declined more sharply following a period of low recruitments from the 2016–2022 year classes (Figure 46). There is no indication of a strong relationship between spawning biomass and annual recruitments (Figure 47).

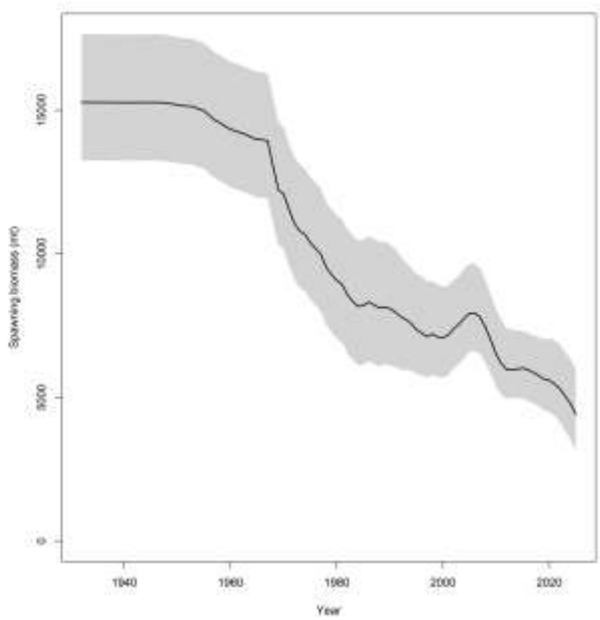

Figure 45: Annual spawning biomass (female, tonnes) from the base western tarakihi assessment model. The shaded grey area represents the 95% confidence interval.

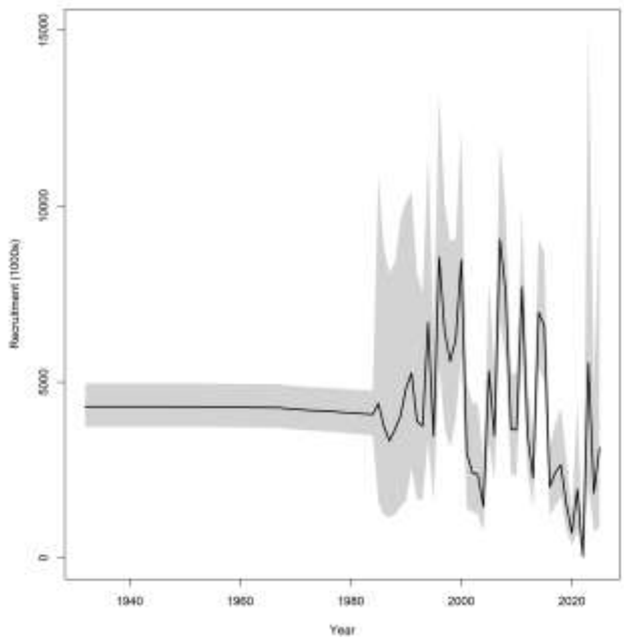

Figure 46: Annual recruitments (in thousands of fish) from the base western tarakihi assessment model. The shaded grey area represents the 95% confidence interval.

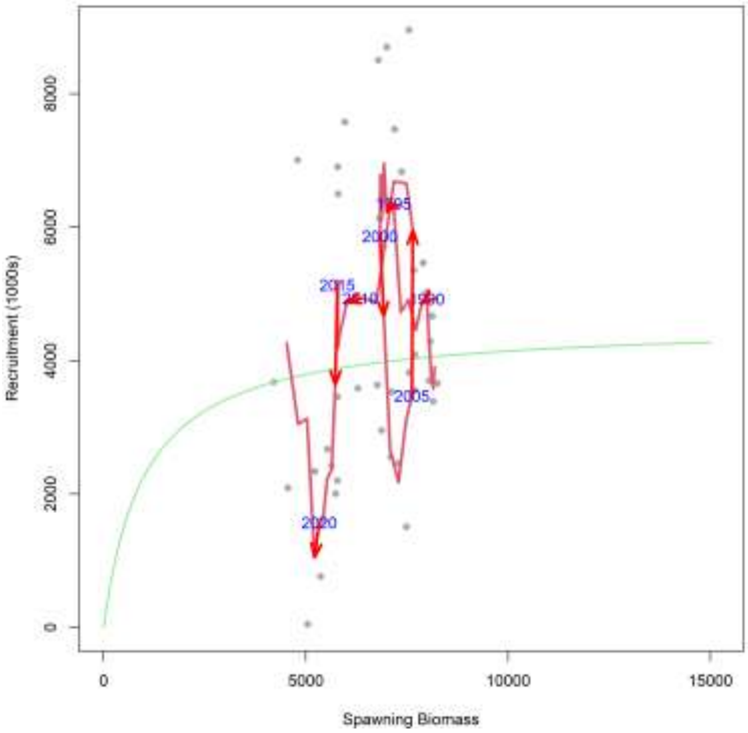

Figure 47: The Beverton-Holt spawner-recruit relationship with the assumed value of 0.8 for steepness (green line). The grey points are the estimated annual recruitments. The red line represents a 3-year moving average with labels at 5-year intervals.

7.6 Model sensitivity runs

A range of model sensitivity runs were conducted, including lower and higher values of natural mortality and higher variation in the recruitment variation (Table 14).

The sensitivity of the model results to the spatial domain of the assessment was evaluated by configuring separate models limited to the TAR 1W area and the TAR 7W area (including WCSI and TBGB) including the constituent catches and observational data from the respective areas only (Table 14). Catches from TAR 8 were not included in either of the two sub area models.

Table 14: Description of model sensitivity runs.

Sensitivity	Description
HighM	$M = 0.125$
LowM	$M = 0.075$
SigmaR09	sigmaR = 0.9
TAR1W	TAR 1W area only
TAR7W	TAR 7W area only

The biomass trajectories are similar for the range of model options and parameter sensitivities, although the stock status is more pessimistic for the model sensitivity runs with lower natural mortality (Figure 48).

The combined biomass from the two sub area models approximates the total biomass from the base model, although the two sub area models do not include the TAR 8 catch (approximately 16% of the total). The TAR1W initial biomass is estimated at about half the magnitude of the TAR 7W biomass component, although depletion is estimated to be greater from the TAR 7W model sensitivity (Figure 48).

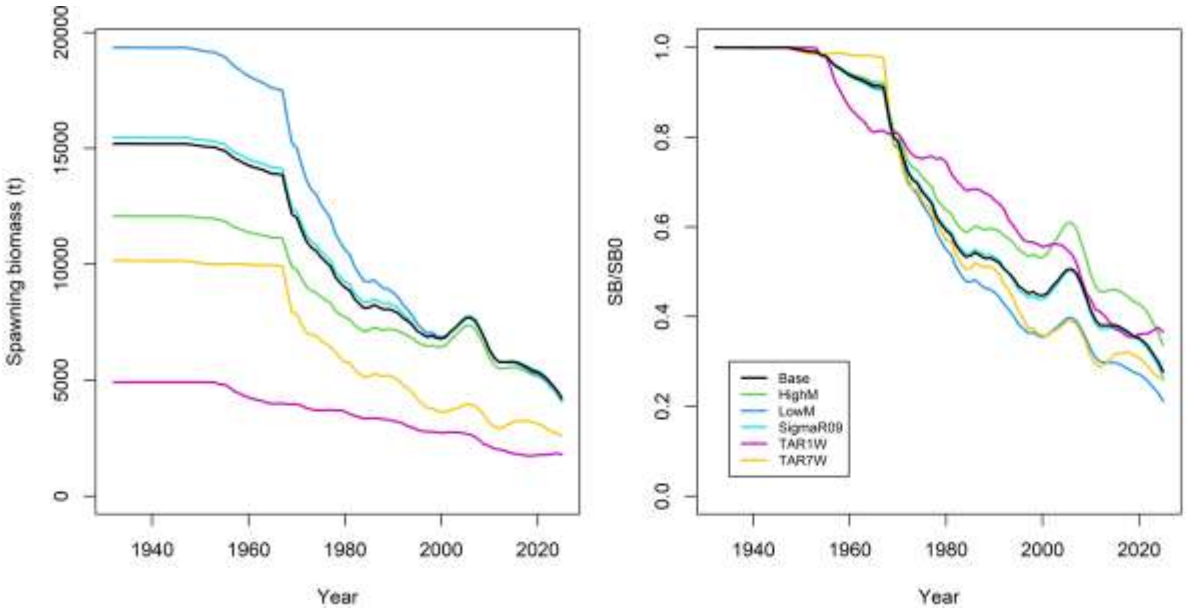

Figure 48: Trends in spawning biomass (left) and spawning biomass relative to reference biomass (*SB_0*) (right) (model MPDs) for the Base model and the range of model sensitivity runs.

7.7 Stock status

For the base case, spawning biomass in 2024–25 was estimated to be below the target biomass (40% SB_0) and above the soft limit of 20% SB_0 (Table 15). Most model sensitivity runs estimate stock status to be within the same range as the Base model, with the exception of the TAR 1W model which estimates stock status to be at about the target biomass level (Table 15).

Table 15: Estimates of current (*SB_{2025}* 2024–25) and equilibrium, unexploited spawning biomass (*SB_0*) (median and the 95% confidence interval from the MCMCs) and probabilities of current biomass being above specified levels for the base case model and associated sensitivity runs and the TAR 1W and TAR 7W area models.

Model option	SB_0 (t)	SB_{2025} (t)	SB_{2025}/SB_0	Pr ($SB_{2025} > X\%SB0$)		
				40%	20%	10%
Base	15 284 (13 257–17 658)	4 419 (3 170–5 986)	0.290 (0.218–0.377)	0.009	0.996	1.000
HighM	12 142 (10 402–14 480)	4 249 (3 080–5 900)	0.353 (0.266–0.468)	0.173	1.000	1.000
LowM	19 337 (17 070–21 844)	4 207 (3 075–5 686)	0.219 (0.165–0.291)	0.000	0.744	1.000
SigmaR09	15 585 (13 154–18 596)	4 240 (3 034–5 770)	0.274 (0.2–0.364)	0.005	0.976	1.000
TAR1W	4 894 (3 972–6 109)	1 917 (1 250–2 853)	0.390 (0.278–0.526)	0.452	1.000	1.000
TAR7W	10 206 (8 544–12 469)	2 782 (1 889–4 117)	0.272 (0.199–0.372)	0.009	0.974	1.000

Annual fishing mortality rates steadily increased throughout the model period and have exceeded the level of fishing mortality that corresponds to default target biomass level (i.e., $F_{SB40\%}$) since the mid-1990s (Figure 49). For the base model, fishing mortality in 2025 was estimated to be well above the reference level (i.e., $F_{2025}/F_{SB40\%} = 1.6$) (Table 16). The estimates of current fishing mortality rates for the two sub area models were lower (i.e., $F_{2025}/F_{SB40\%}$ ~1.2) presumably because catches from the TAR 8 fishery were not included in either model.

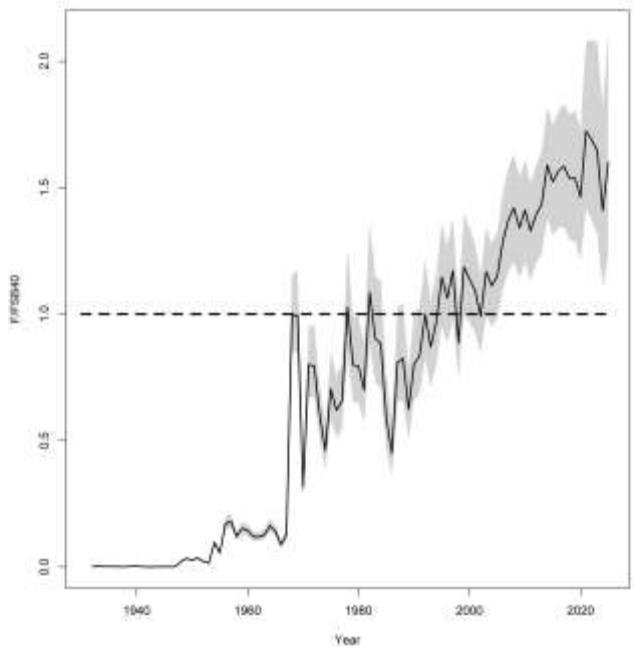

Figure 49: Annual trend in fishing mortality relative to the $F_{SB40\%}$ interim target biomass level for the base west coast tarakihi model. The line represents the median and the shaded area represents the 95% credible interval.

Table 16: Estimates of current (F_{2025} 2024–25) and reference levels of fishing mortality ($F_{SB40\%}$) (median and the 95% confidence interval from the MCMCs) and the probability of fishing mortality being below the level of fishing mortality associated with the interim target biomass level for the base case model and associated sensitivity runs.

Model option	F_{SB40}	$F_{2025}/F_{SB40\%}$		Pr(F_{2025}<$F_{SB40\%}$	$F_{SB40\%}$ *Yield*	
		Median	95% CI		Median	95% CI
Base	0.064	1.599	1.228–2.116	0.001	714	518–967
HighM	0.074	1.224	0.917–1.617	0.093	966	706–1344
LowM	0.052	2.297	1.804–2.963	0.000	474	355–627
SigmaR09	0.065	1.671	1.263–2.205	0.000	666	483–914
TAR1W	0.065	1.160	0.818–1.666	0.195	–	–
TAR7W	0.053	1.231	0.905–1.64	0.088	–	–

Projections

For the base model, stock projections were conducted for the 5-year period following the terminal year of the model (i.e., 2025–26 to 2029–30). During the projection period, the average level of recruitment was assumed to be equivalent to the average of estimated recruitment from the recent period (2014–23). Variation in projected recruitments was incorporated based on the *sigmaR* value (0.6).

Stock projections were conducted for three options: a) 2024–25 TACCs, including western splits for TAR 1 and TAR 7 and 10% allowance for unreported catch and recreational catch (total catch of 1 843 t), b) status quo (2024–25) commercial and recreational catches, including the 10% allowance for unreported catch (total catch of 1162 t), and c) constant fishing mortality at *FSB40%*.

Spawning biomass is predicted to decline under current levels of catch and decline to a greater extent under current TACC levels (Table 17). The short-term projections are strongly influenced by the low recruitments estimated for the recent years (2016–2022). Predicted average catches under constant fishing mortality are estimated at about 700 t per annum.

Table 17: Estimated stock status (and 95% confidence intervals) and the probabilities of the spawning biomass being above default biomass limits and interim target level in 2030 (5 years) from catch and TACC based projections for the base case.

Projection option			Pr (SB_{2030} > X%SB_0)		
	Median	95% CI	10%	20%	40%
TACC	0.095	0.019–0.214	0.462	0.039	0.000
Catch	0.190	0.108–0.309	0.984	0.421	0.002
FSB40%	0.258	0.202–0.346	1.000	0.982	0.003

7.8 Stock relationships

The recruitment estimates from the current assessment were compared with the corresponding recruitment series from the 2026 eastern tarakihi stock assessment (Langley in prep.). Overall, the scale of recruitment for the western stock is considerably lower than the eastern recruitment (Figure 50 and Figure 51). For both models, estimates of annual recruitments are more precise from 1990 onwards. The magnitude of the inter-annual variation in recruitment is similar for the two stocks (Figure 50).

Both assessments estimate recruitment to have been below average (and generally declining) during 2016–2022. There is also a general correspondence in the recruitments between the two stocks with strong year classes in the eastern stock (i.e., 1997, 2007, 2011 and 2015) also evident as strong year classes in the western stock (Figure 50 and Figure 51). However, there are strong year classes in the western stock that are estimated to be either at or below average recruitment for the eastern stock (i.e., 1997–2000, 2005, 2008 and 2014). Conversely, there are a number of weak year classes in the western stock that are estimated to be at least average strength for the eastern stock (i.e., 2003, 2004 and 2012) (Figure 50 and Figure 51).

These observations suggest that in some years there are broad scale environmental processes that are influencing tarakihi recruitment in both areas, whereas there is a decoupling of the recruitment processes in other years. Those differences in annual recruitments between the two assessments strengthen the current stock hypothesis for tarakihi around mainland New Zealand.

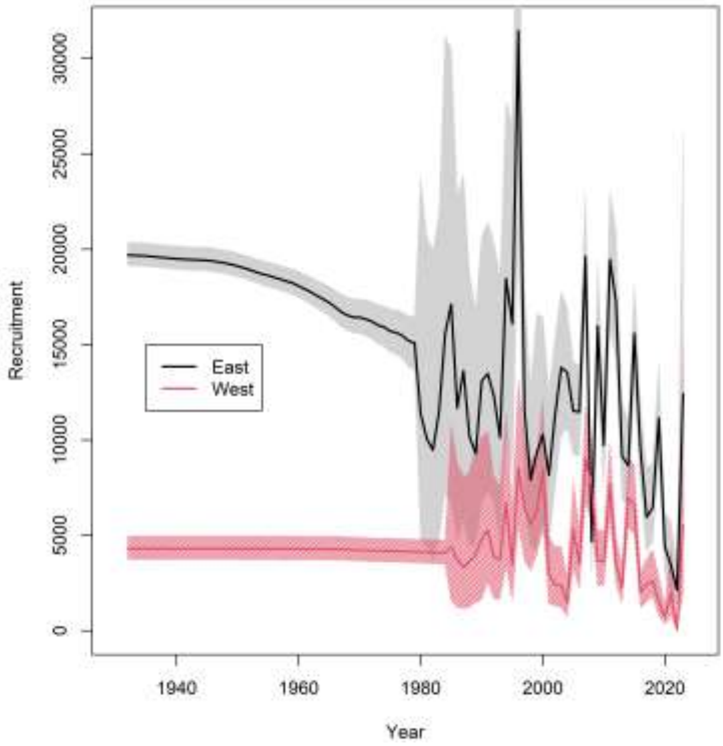

Figure 50: A comparison of the time series of annual recruitments from the current western tarakihi assessment (red line) and 2026 eastern tarakihi stock assessment (black line) (Langley in prep.). The shaded areas represent the 95% confidence intervals.

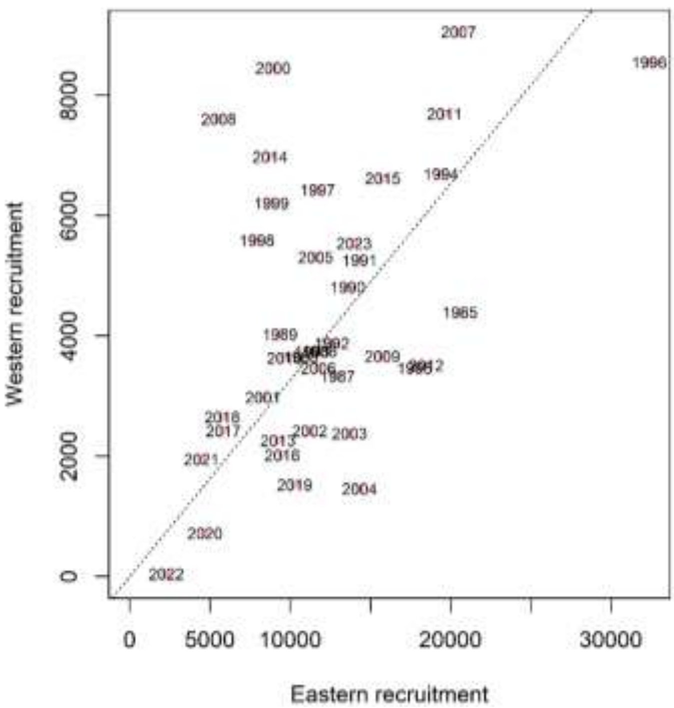

Figure 51: The correlation between the annual recruitments for 1985–2023 from the current western tarakihi assessment and 2026 eastern tarakihi stock assessment (Langley in prep). The dashed line represents the linear relationship between the two data sets (zero intercept).

8. DISCUSSION

This study represents the first full stock assessment for the western stock of tarakihi. The assessment was accepted by the Fishery Assessment Plenary in May 2026.

The assessment estimates that the stock had declined to the default target biomass level (40% SB_0) by 2010. The magnitude of the decline is strongly informed by the age composition data from the WCSI trawl survey and, more recently, the main commercial fisheries. Trends in abundance over the last 25-30 years are mediated by the biomass indices from the trawl surveys and the CPUE indices from the WCNI fishery.

Stock biomass is estimated to have declined over the last 10–15 years (to 2024–25) and is predicted to decline further due, in part, to a period of low recruitment in recent years (2016–2022).

The accumulation of age composition data from trawl surveys and commercial fisheries has further contributed to our understanding of the stock structure of tarakihi around mainland New Zealand. There is a clear delineation between western and eastern stocks based on differences in growth rates and variation in recruitment and trends in abundance indices supported by direct observations from tag release/recovery data.

There are persistent patterns in recruitment variation from the constituent areas of the western stock. However, there are distinct spawning grounds off the west coast of the South Island and northern west coast of the North Island and there is likely to be a degree of spatial separation of tarakihi within the wider western stock area. The separate models configured for the TAR 1W and TAR 7W sub areas contrast the broader stock assumption of the base assessment model. The overall estimates of stock status are relatively insensitive to those stock area assumptions.

The inshore trawl surveys conducted by R.V. *Kaharoa*, particularly the WCSI surveys, have provided crucial inputs to the current stock assessment. The replacement of the vessel with *Kaharoa II* in 2025 will require a recalibration of the series of abundance indices between the two vessels, either externally (Devine et al. 2026) or within the assessment modelling framework.

The first WCNI survey by *Kaharoa II* was conducted in February-March 2025 (Jones et al. 2026). While the timing differed from the previous *Kaharoa* surveys, the age composition and abundance of tarakihi was comparable to the relatively low biomass from the 2022 *Kaharoa* survey. *Kaharoa II* is scheduled to conduct the next WCSI trawl survey in March-April 2027.

The Plenary accepted the assessment but recommended further refinements in the CPUE indices incorporated in future west coast stock assessments, specifically the application of spatio-temporal modelling approaches (e.g. using *tinyVAST*, Thorson et al. 2025) to improve the coverage of the indices. Further consideration should also be given to the constituent fisheries included within the CPUE analysis, especially where there are marked differences in the age composition of the catch between fisheries, as has been evident from the sampling of TAR 8 commercial catches from target and bycatch fisheries.

Future assessments should also incorporate historical age data, in particular the age compositions sampled by surveys conducted by R.V. *James Cook* in the early 1970s (Vooren 1977). Those data inform the current estimate of natural mortality for tarakihi. Ideally, the estimation of natural mortality would be integrated within the assessment framework.

The recent (2016–2022) low recruitments have corresponded to a period of warmer sea temperatures off western New Zealand. Further work is required to investigate the relationship between tarakihi recruitment and prevailing oceanographic conditions. It is unknown whether the recent low recruitments are simply a transient process or represent a longer-term shift in the overall productivity of the stock. Ongoing monitoring of recruitment will be important for monitoring the west coast tarakihi stock over the medium term (5–10 years).

9. ACKNOWLEDGMENTS

This study was funded by Fisheries New Zealand under Project TAR2024-01. The assessment incorporates a wide range of data collected by numerous people over at least 30 years. Jeremy McKenzie and the team of sampling and aging staff at Earth Sciences New Zealand (formerly NIWA), supported by Cameron Walsh (Stock Monitoring Services), provided key age composition data sets. Trawl survey data sets were provided by Dan MacGibbon (ESNZ) and by the Fisheries Data Management Team at Fisheries New Zealand. The assessment was conducted in Stock Synthesis software developed and supported by Rick Methot (NOAA). Members of the Inshore Fishery Assessment Working Group, in particular Marc Griffiths (Fisheries New Zealand), provided valuable comments during the development of the assessment.

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APPENDIX 1: WCNI CPUE ANALYSIS

The WCNI Trawl CPUE indices were derived from the trawl event-based data available from 1993–94. The data selection criteria are presented in Table A1.

Table A1: Data selection for the WCNI Trawl CPUE data set.

Attribute	Selection criteria	Number of records retained	TAR catch (t) retained
Fishing Years	1993–94 to 2024–25		
Statistical Area	045, 046, 047	61 685	9 148.1
Fishing method	BT, PRB	61 685	9 148.1
Depth range	10–500 m	61 624	9 141.5
Target species	TAR, SNA, TRE	49 646	8 537.8
Tarakihi catch	< 6000 kg	49 642	8 504.6
Fishing duration	1–6 h	46 652	6 923.4
Vessel continuity	5 trips, 5+ years	40 969	6 105.9
Trawl speed	2.0–4.5	40 793	6 090.0
GearWidth	10–50	37 886	5 680.2
Headline height	1–10	36 917	5 590.2
Final data set		36 917	5 590.2

Table A2: Summary of the WCNI Trawl CPUE data set (core vessels only).

Fishing year	Number records	Number vessels	Number trips	Catch (t)	Number trawls	Duration (hrs)	Percent zero catch
1993–94	456	9	47	5.5	456	1 227	71.3
1994–95	621	6	58	81.9	621	1 940	57.0
1995–96	1 017	15	140	112.7	1 017	3 110	65.6
1996–97	1 709	14	242	159.1	1 709	5 135	55.1
1997–98	2 176	14	247	164.9	2 176	6 470	61.3
1998–99	1 915	14	199	188.3	1 915	5 452	59.7
1999–00	1 782	12	208	198.5	1 782	5 946	66.9
2000–01	1 592	13	177	164.0	1 592	5 557	68.3
2001–02	1 103	14	166	184.9	1 103	4 024	59.4
2002–03	1 040	12	139	215.9	1 040	3 900	59.1
2003–04	1 451	12	163	193.1	1 451	5 226	59.9
2004–05	1 154	11	127	183.6	1 154	4 142	64.2
2005–06	737	8	99	171.0	737	2 634	56.4
2006–07	930	7	103	90.9	930	2 931	65.5
2007–08	1 114	6	133	214.3	1 114	3 941	63.6
2008–09	1 155	4	118	236.4	1 155	4 055	64.1
2009–10	1 035	4	93	124.8	1 035	3 169	63.0
2010–11	1 127	6	122	231.4	1 127	3 701	56.4
2011–12	1 370	6	135	169.2	1 370	4 491	62.2
2012–13	1 284	6	137	175.8	1 284	4 133	50.9
2013–14	1 348	8	166	302.6	1 348	4 498	57.0
2014–15	1 482	8	169	266.9	1 482	5 135	47.6
2015–16	1 539	7	139	250.6	1 539	5 022	47.3
2016–17	1 503	7	163	297.6	1 503	5 259	50.1
2017–18	932	7	111	177.7	932	3 174	51.6
2018–19	1 007	8	111	206.4	1 007	3 619	43.6
2019–20	1 128	6	118	206.4	1 128	4 156	44.8
2020–21	926	5	126	259.2	926	3 425	38.4
2021–22	1 145	8	139	190.9	1 145	3 812	52.8
2022–23	691	4	85	108.3	691	2 417	54.1
2023–24	107	4	27	6.6	107	365	45.8
2024–25	327	4	71	49.0	327	1 209	52.9

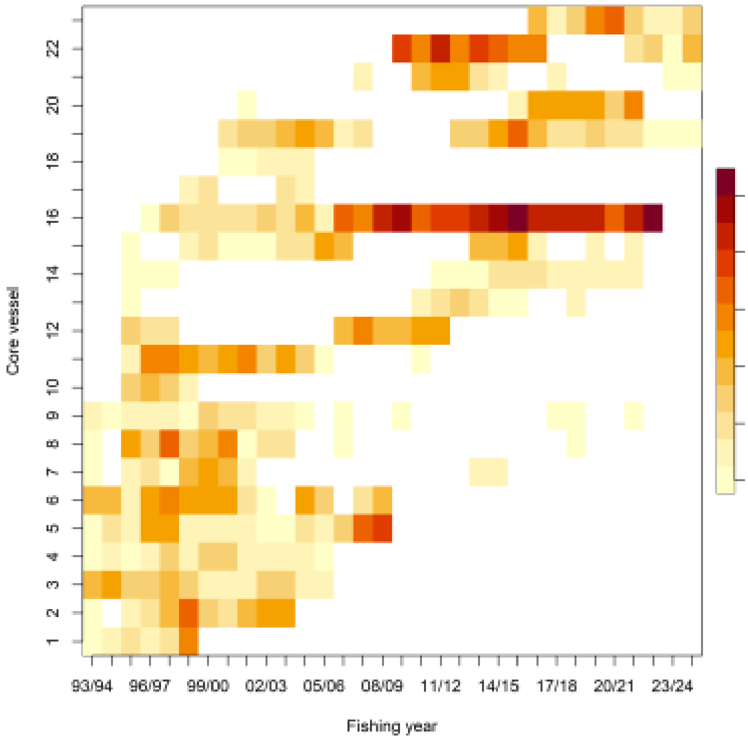

Figure A1: Annual number of trawl event records for each vessel included in the WCNI Trawl core fleet. The colour of the cell represents the number of records from low (pale yellow) to high (dark red).

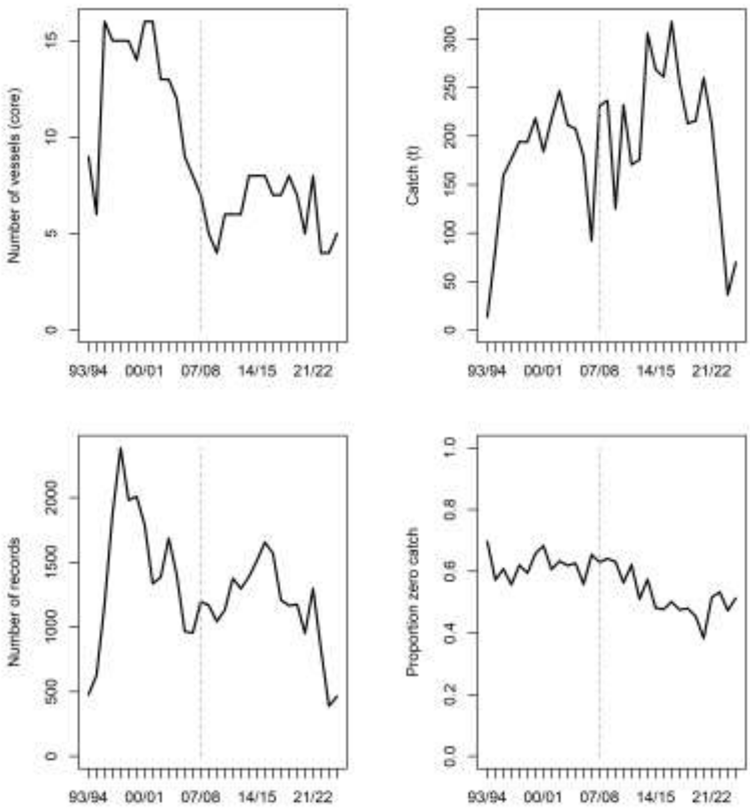

Figure A2: A summary of the data included in the WCNI Trawl CPUE data set.

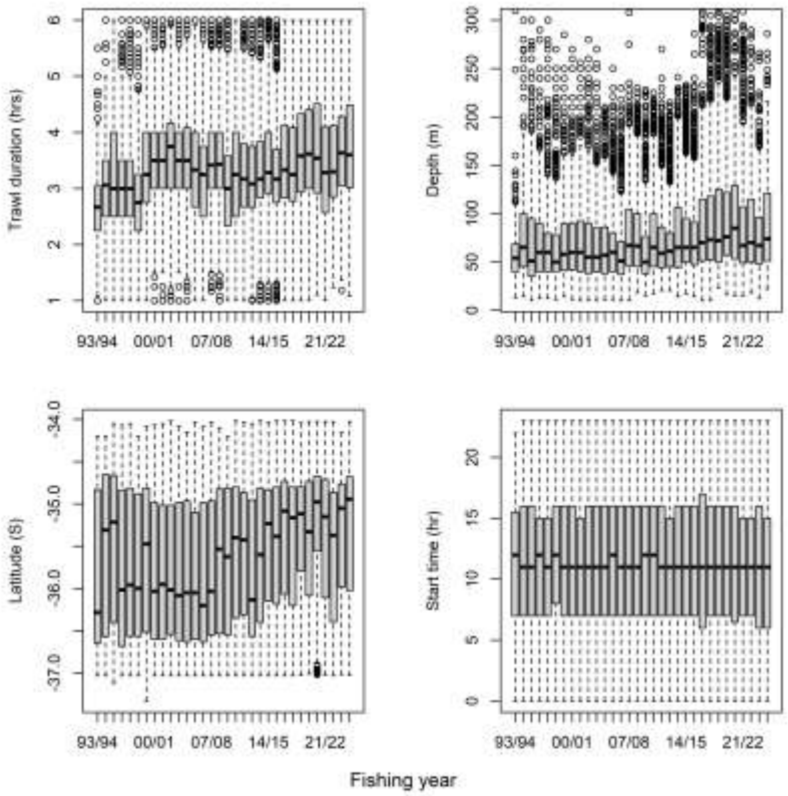

Figure A3: A summary of the fishing event data included in the WCNI Trawl CPUE data set.

Table A3: Summary of stepwise selection of variables in the WCNI Trawl positive catch CPUE model. Model terms are listed in the order of acceptance to the model.

Term	Degrees of freedom	Deviance	Residual deviance	R^2	Improvement
Null model			93 399		
FishingYear	31	7 089.0	86 310	0.076	
Depth	3	38 637.0	47 673	0.490	41.4%
Latitude	5	7 140.0	40 533	0.566	7.6%
Vessel	23	3 143.0	37 390	0.600	3.4%
TargetSpecies	2	1 743.0	35 646	0.618	1.9%
Duration	3	896.0	34 750	0.628	1.0%

Table A4: Summary of stepwise selection of variables in the WCNI Trawl occurrence CPUE model. Model terms are listed in the order of acceptance to the model.

Term	Degrees of freedom	Deviance	Residual deviance	R^2	Improvement
Null model			55 670		
FishingYear	31	883.3	54 787	0.016	
TargetSpecies	2	12 948.0	41 839	0.248	23.3%
Depth	3	1 122.5	40 716	0.269	2.0%
Month	11	963.1	39 753	0.286	1.7%
Vessel	23	714.3	39 039	0.299	1.3%
Latitude	5	331.7	38 707	0.305	0.6%
StartTime	3	335.4	38 372	0.311	0.6%

Table A5: WCNI Trawl CPUE indices and associated lower bound (LCI) and upper bound (UCI) of the 95% confidence intervals.

Fishing	Combined			Binomial			Lognormal		
year	Index	LCI	UCI	Index	LCI	UCI	Index	LCI	UCI
1993–94	0.307	0.208	0.428	0.303	0.241	0.368	1.000	0.737	1.329
1994–95	0.789	0.540	1.075	0.314	0.256	0.380	2.517	1.872	3.350
1995–96	0.991	0.692	1.378	0.304	0.245	0.368	3.262	2.464	4.290
1996–97	0.809	0.586	1.084	0.382	0.323	0.444	2.114	1.616	2.697
1997–98	0.867	0.640	1.146	0.359	0.306	0.421	2.416	1.866	3.073
1998–99	1.279	0.936	1.705	0.400	0.337	0.465	3.199	2.507	4.048
1999–00	1.161	0.845	1.587	0.355	0.295	0.418	3.273	2.528	4.265
2000–01	1.308	0.927	1.748	0.301	0.249	0.360	4.339	3.308	5.569
2001–02	0.880	0.631	1.197	0.328	0.273	0.390	2.685	2.047	3.528
2002–03	1.197	0.834	1.667	0.300	0.243	0.359	3.990	2.985	5.162
2003–04	0.906	0.656	1.225	0.321	0.267	0.384	2.823	2.149	3.616
2004–05	1.478	1.047	2.005	0.345	0.282	0.408	4.292	3.306	5.507
2005–06	1.141	0.817	1.563	0.372	0.311	0.440	3.070	2.342	4.048
2006–07	0.756	0.517	1.079	0.366	0.296	0.439	2.063	1.528	2.735
2007–08	0.964	0.667	1.351	0.230	0.178	0.286	4.183	3.155	5.371
2008–09	0.744	0.512	1.039	0.218	0.172	0.269	3.417	2.556	4.415
2009–10	0.772	0.538	1.100	0.352	0.288	0.425	2.188	1.621	2.927
2010–11	0.952	0.663	1.319	0.315	0.256	0.378	3.028	2.261	3.931
2011–12	0.605	0.417	0.874	0.288	0.231	0.352	2.103	1.563	2.756
2012–13	0.895	0.644	1.214	0.474	0.400	0.554	1.888	1.408	2.453
2013–14	0.701	0.495	1.008	0.309	0.246	0.370	2.269	1.712	3.020
2014–15	0.741	0.533	1.000	0.431	0.364	0.500	1.718	1.303	2.255
2015–16	0.791	0.566	1.065	0.443	0.373	0.509	1.788	1.366	2.309
2016–17	0.627	0.440	0.850	0.318	0.256	0.385	1.974	1.480	2.582
2017–18	0.635	0.442	0.867	0.402	0.330	0.477	1.581	1.209	2.042
2018–19	0.375	0.263	0.528	0.363	0.300	0.433	1.032	0.786	1.339
2019–20	0.577	0.403	0.775	0.438	0.364	0.511	1.317	0.983	1.721
2020–21	0.677	0.482	0.929	0.464	0.390	0.539	1.459	1.094	1.931
2021–22	0.500	0.355	0.686	0.392	0.322	0.466	1.277	0.935	1.649
2022–23	0.681	0.465	0.964	0.387	0.313	0.462	1.759	1.313	2.302
2023–24	0.820	0.527	1.199	0.423	0.331	0.520	1.937	1.372	2.675
2024–25	0.591	0.376	0.848	0.343	0.262	0.436	1.722	1.240	2.308

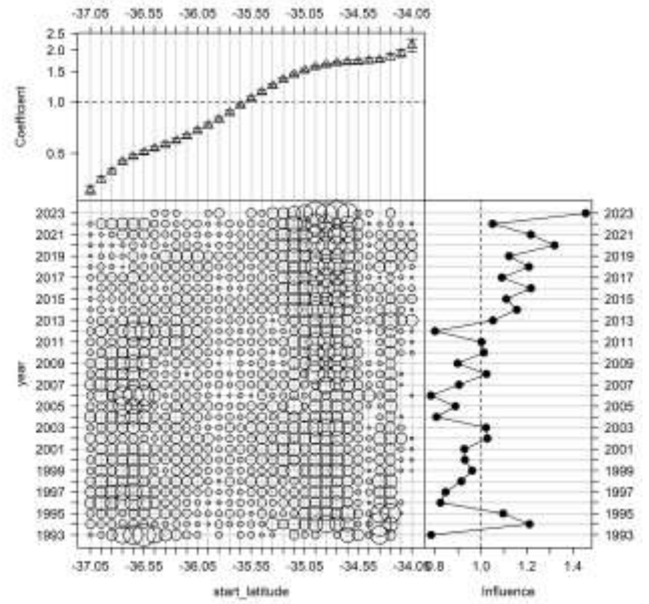

Figure A4: Influence plot of the Latitude variable in the WCNI Trawl positive catch CPUE model.

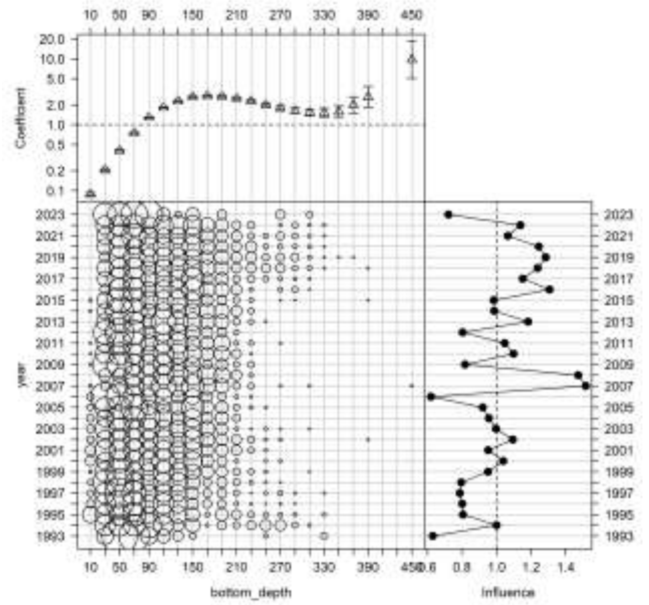

Figure A5: Influence plot of the Depth variable in the WCNI Trawl positive catch CPUE model.

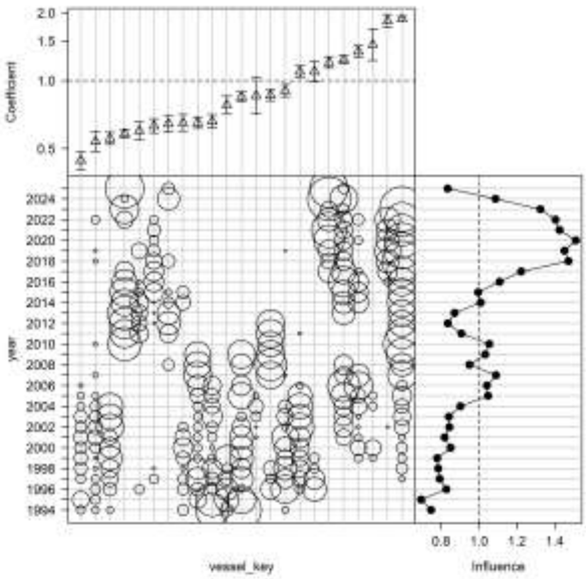

Figure A6: Influence plot of the Vessel variable in the WCNI Trawl positive catch CPUE model.

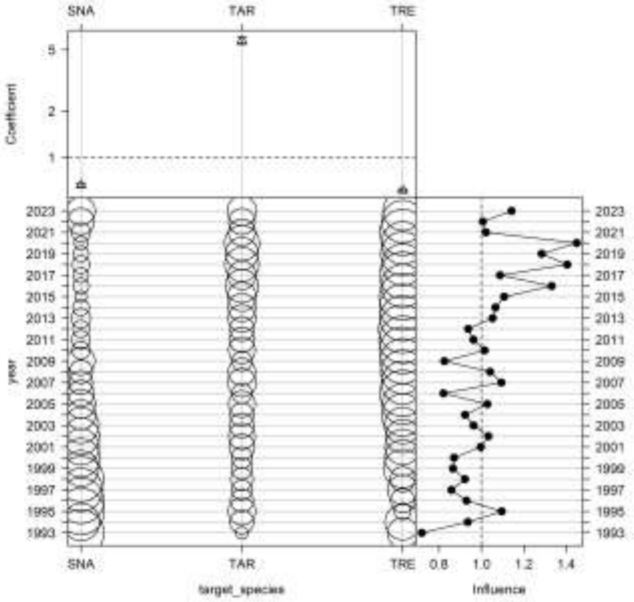

Figure A7: Influence plot of the Target Species variable in the WCNI Trawl occurrence CPUE model.

APPENDIX 2: TAR 8 CPUE ANALYSIS

The TAR8 Trawl CPUE indices were derived from the trawl event-based data available from 2007–08. The data selection criteria are presented in Table A6.

Table A6: Data selection for the TAR8 Trawl CPUE data set.

Attribute	Selection criteria	Number of records retained	TAR catch (t) retained
Fishing Years	2007–08 to 2024–25		
Statistical Area	037, 039, 040, 041, 801	42 927	5 334.7
Fishing method	BT	41 583	4 780.0
Depth range	10–300 m	40 492	4 778.9
Target species	≠ (JMA, FLA)	39 568	4 717.3
Tarakihi catch	< 6000 kg	39 558	4 675.8
Fishing duration	1–6 h	38 649	4 441.8
Vessel continuity	5 trips, 5+ years	29 291	4 015.9
Trawl speed	2.5–4.0	29 036	3 985.5
GearWidth	10–50	27 025	3 668.5
Headline height	1–10	21 176	3 163.4
Final data set		21 176	3 163.4

Table A7: Summary of the TAR8 Trawl CPUE data set (core vessels only).

Fishing year	Number records	Number vessels	Number trips	Catch (t)	Number trawls	Duration (hrs)	Percent zero catch
2007–08	1 157	15	275	89.5	1 157	4 297	43.6
2008–09	1 294	15	283	108.9	1 294	4 959	42.1
2009–10	1 438	15	300	128.9	1 438	5 235	40.5
2010–11	1 679	15	331	182.0	1 679	5 984	38.2
2011–12	1 799	18	336	232.2	1 799	6 730	35.9
2012–13	1 523	15	309	177.5	1 523	5 815	39.1
2013–14	1 408	15	318	254.0	1 408	5 578	35.7
2014–15	1 371	16	304	291.5	1 371	5 439	33.1
2015–16	1 371	16	283	322.7	1 371	5 407	30.3
2016–17	1 302	15	254	253.7	1 302	4 943	34.1
2017–18	1 512	15	253	244.4	1 512	5 835	36.6
2018–19	1 247	16	199	235.5	1 247	4 766	31.5
2019–20	1 177	15	177	150.1	1 177	4 627	31.9
2020–21	776	12	142	128.7	776	3 133	39.3
2021–22	679	13	114	127.5	679	2 760	31.1
2022–23	533	9	79	143.9	533	2 114	25.1
2023–24	469	7	79	57.2	469	1 915	45.0
2024–25	441	7	70	35.3	441	1 799	51.9

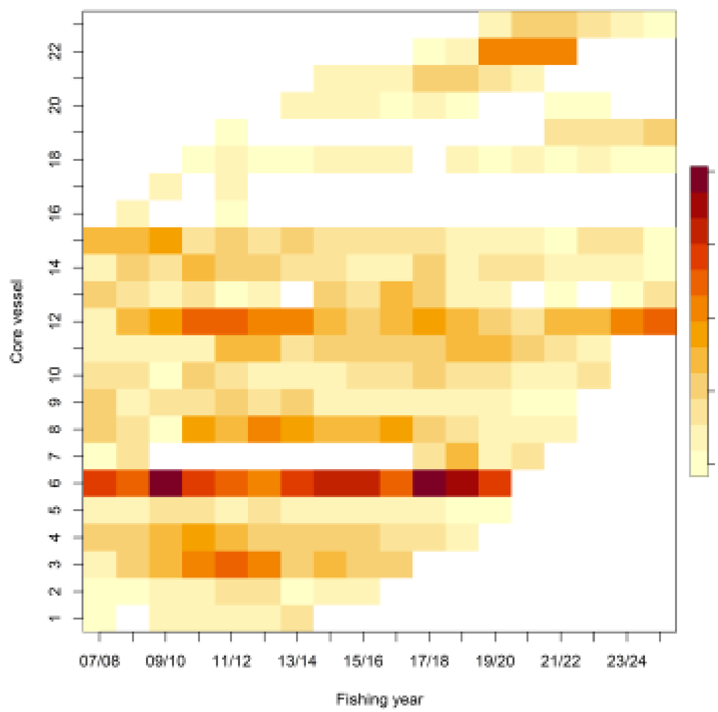

Figure A8: Annual number of trawl event records for each vessel included in the TAR8 Trawl core fleet. The colour of the cell represents the number of records from low (pale yellow) to high (dark red).

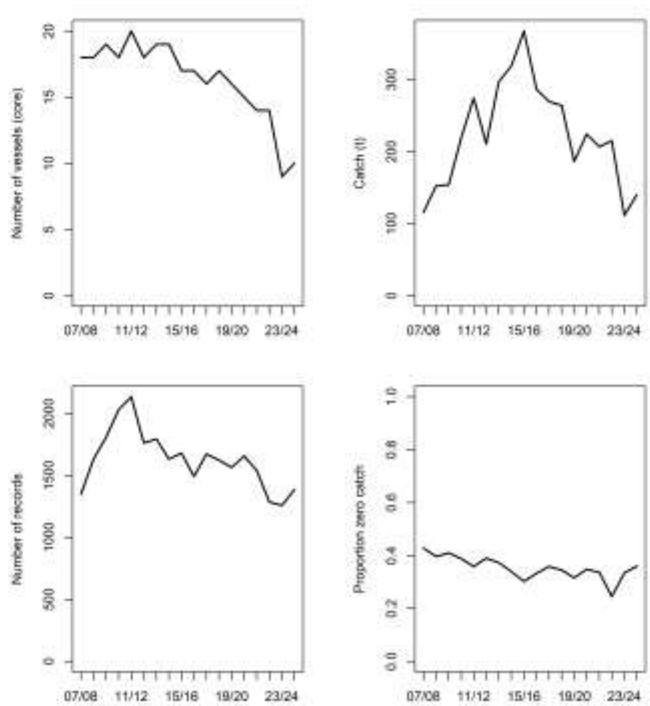

Figure A9: A summary of the data included in the TAR8 Trawl CPUE data set.

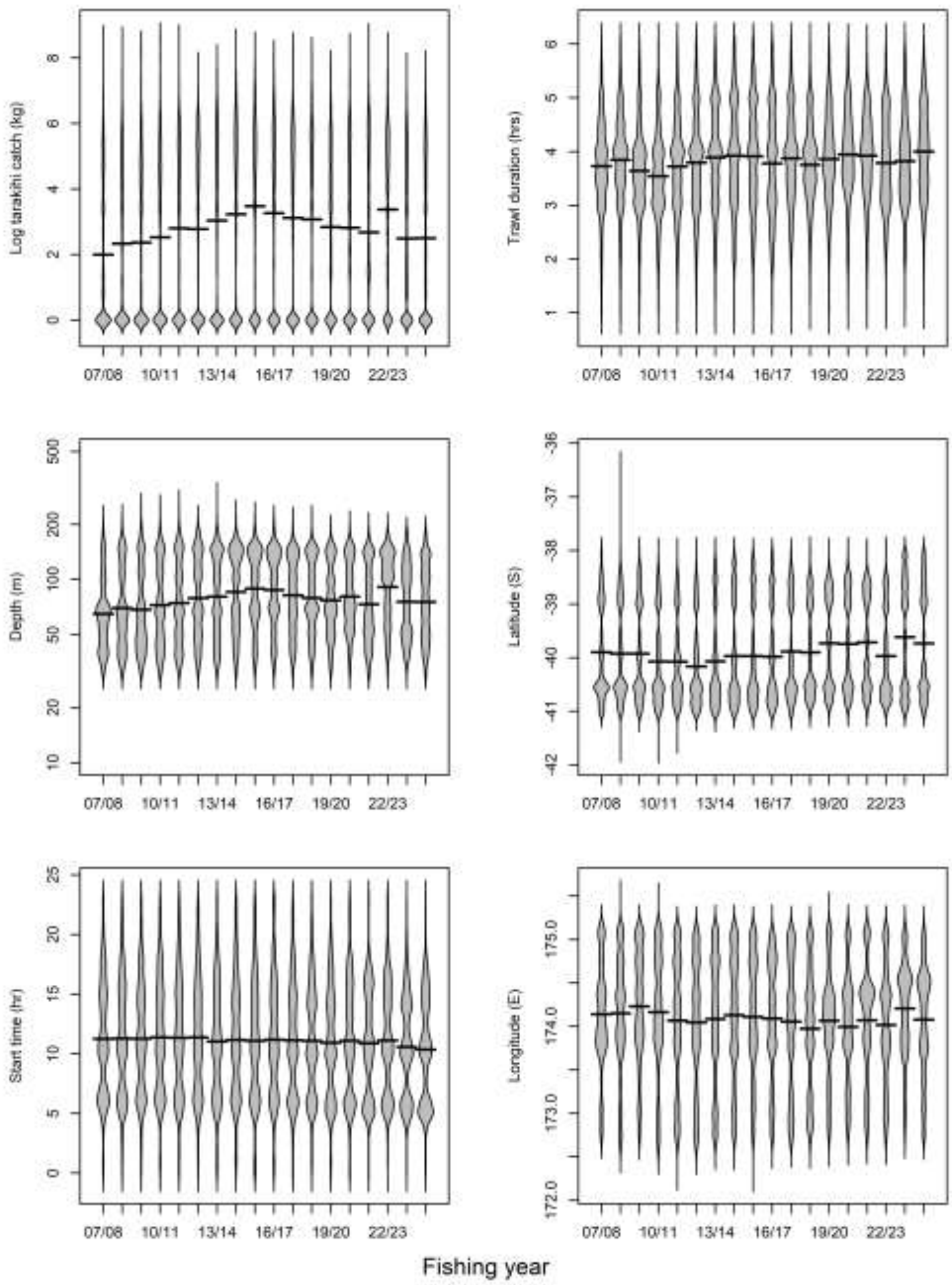

Figure A10: A summary of the fishing event data included in the TAR8 Trawl CPUE data set.

Table A8: Summary of stepwise selection of variables in the TAR8 Trawl positive catch CPUE model. Model terms are listed in the order of acceptance to the model.

Term	Degrees of freedom	Deviance	Residual deviance	R^2	Improvement
Null model			45 364		
FishingYear	17	3 560.9	41 803	0.078	
Depth	3	16 148.0	25 655	0.434	35.6%
Longitude	5	2 853.0	22 802	0.497	6.3%
Vessel	22	1 352.1	21 450	0.527	3.0%
Month	11	527.4	20 922	0.539	1.2%
Latitude	5	487.6	20 435	0.550	1.1%
Duration	3	413.8	20 021	0.559	0.9%

Table A9: Summary of stepwise selection of variables in the TAR8 Trawl occurrence CPUE model. Model terms are listed in the order of acceptance to the model.

Term	Degrees of freedom	Deviance	Residual deviance	R^2	Improvement
Null model			27 809		
FishingYear	17	217.9	27 592	0.008	
Depth	3	8 042.6	19 549	0.297	28.9%
Vessel	22	908.0	18 641	0.330	3.3%
Longitude	5	462.3	18 179	0.346	1.7%
Month	11	407.0	17 772	0.361	1.5%

Table A10: TAR8 Trawl CPUE indices and associated lower bound (LCI) and upper bound (UCI) of the 95% confidence intervals.

Fishing	Combined			Binomial			Lognormal		
year	Index	LCI	UCI	Index	LCI	UCI	Index	LCI	UCI
2007–08	0.564	0.478	0.661	0.564	0.509	0.617	1.000	0.873	1.149
2008–09	0.546	0.461	0.641	0.562	0.505	0.616	0.971	0.857	1.099
2009–10	0.667	0.565	0.778	0.507	0.450	0.562	1.316	1.164	1.485
2010–11	0.638	0.535	0.744	0.542	0.481	0.600	1.178	1.043	1.333
2011–12	0.698	0.587	0.823	0.539	0.482	0.599	1.295	1.143	1.460
2012–13	0.540	0.442	0.654	0.418	0.357	0.478	1.294	1.133	1.471
2013–14	0.682	0.566	0.814	0.426	0.370	0.488	1.602	1.410	1.825
2014–15	0.770	0.629	0.911	0.453	0.387	0.507	1.701	1.493	1.923
2015–16	0.818	0.667	0.979	0.442	0.386	0.504	1.851	1.612	2.084
2016–17	0.720	0.584	0.871	0.417	0.352	0.480	1.724	1.525	1.952
2017–18	0.682	0.561	0.826	0.408	0.350	0.466	1.672	1.453	1.906
2018–19	0.840	0.691	1.015	0.484	0.416	0.549	1.737	1.506	1.987
2019–20	0.709	0.584	0.855	0.518	0.449	0.584	1.368	1.185	1.579
2020–21	0.638	0.483	0.807	0.379	0.304	0.451	1.682	1.414	1.974
2021–22	0.848	0.675	1.048	0.583	0.499	0.663	1.456	1.228	1.719
2022–23	0.806	0.608	1.010	0.512	0.416	0.600	1.575	1.331	1.852
2023–24	0.725	0.545	0.934	0.501	0.413	0.597	1.447	1.202	1.753
2024–25	0.525	0.384	0.701	0.514	0.418	0.602	1.023	0.801	1.262

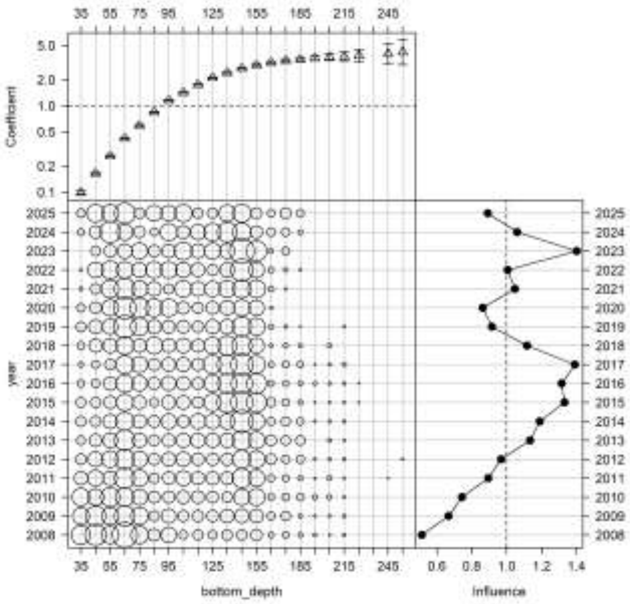

Figure A11: Influence plot of the Depth variable in the TAR8 Trawl positive catch CPUE model.

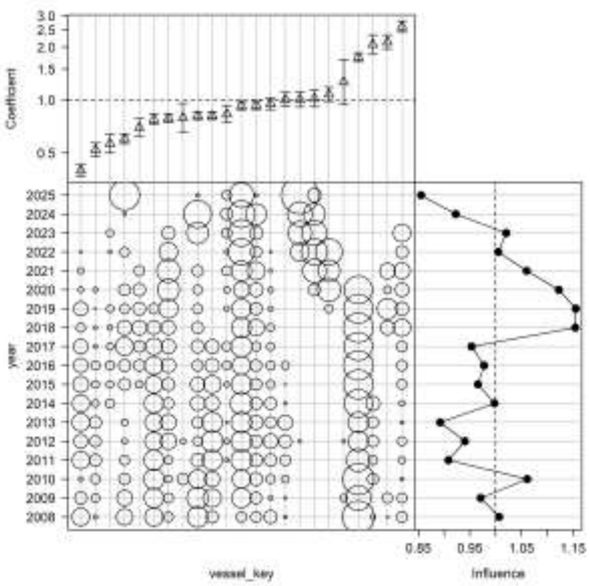

Figure A12: Influence plot of the Vessel variable in the TAR8 Trawl positive catch CPUE model.

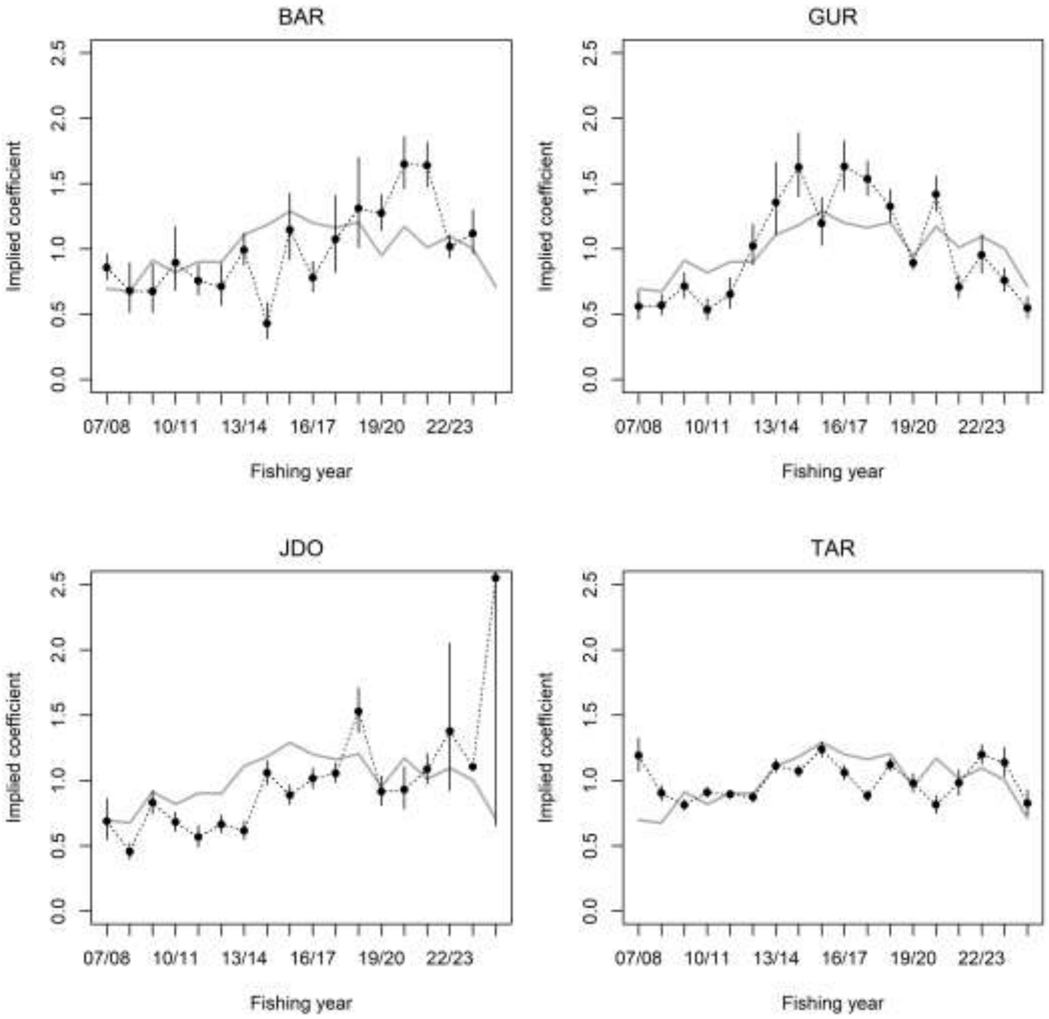

Figure A13: Annual trends in the residuals (points) by declared target species from the TAR8 Trawl positive catch CPUE model. The grey line represents the base indices.

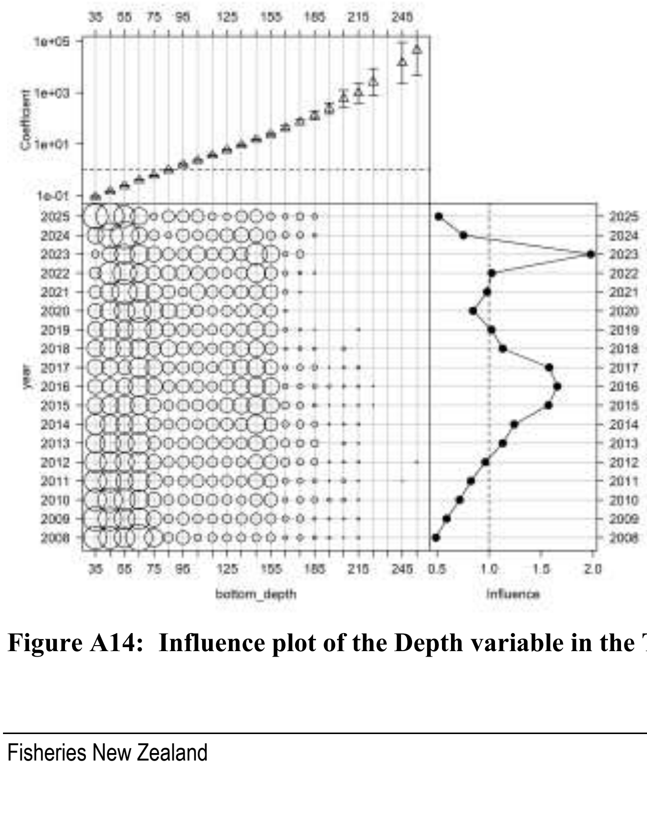

Figure A14: Influence plot of the Depth variable in the TAR8 Trawl occurrence CPUE model.

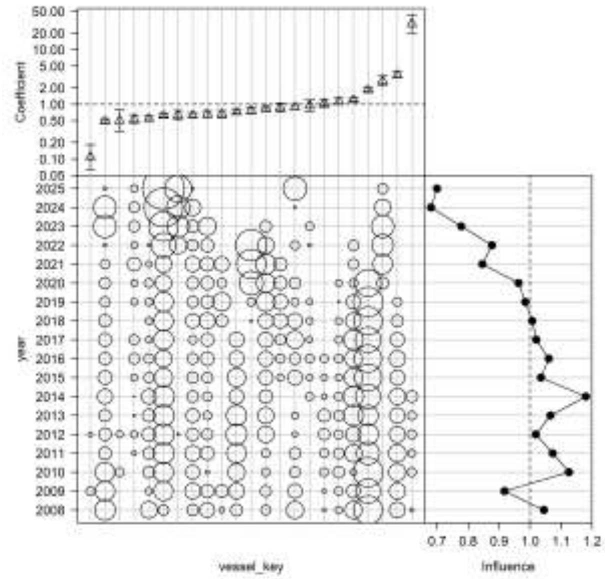

Figure A15: Influence plot of the Vessel variable in the TAR8 Trawl occurrence CPUE model.

APPENDIX 3: WCSI CPUE ANALYSIS

The WCSI Trawl CPUE indices were derived from the daily aggregated data from 1989–90 to 2024–25. The data selection criteria are presented in Table A11.

Table A11: Data selection for the WCNI Trawl CPUE data set.

Attribute	Selection criteria	Number of records retained	TAR catch (t) retained
Fishing Years	1989–90 to 2024–25		
Statistical Area	033, 034, 035, 036	77 604	20 304.3
Fishing method	BT	65 189	20 110.6
Target species	TAR, RCO, BAR, WAR,	40 695	18 080.0
Tarakihi catch	< 6000 kg	40 687	18 012.0
Fishing duration	1–18 h	37 720	15 645.4
Vessel continuity	1000 kg, 5+ years	33 191	14 691.1
Final data set		33 191	14 691.1

Table A12: Summary of the WCSI Trawl CPUE data set (core vessels only).

Fishing year	Number records	Number vessels	Number trips	Catch (t)	Number trawls	Duration (hrs)	Percent zero catch
1989–90	501	14	114	143.8	1 534	4 387	14.6
1990–91	739	20	185	210.5	1 986	6 346	19.6
1991–92	1 007	24	282	269.8	2 860	10 355	19.0
1992–93	1 220	25	342	405.1	3 672	12 461	26.9
1993–94	801	23	245	312.5	2 290	7 177	28.0
1994–95	776	25	235	346.5	2 098	6 863	28.0
1995–96	913	26	281	344.9	2 524	8 528	23.8
1996–97	1 004	25	273	415.0	2 768	9 995	17.3
1997–98	584	17	194	246.1	1 646	5 527	20.2
1998–99	991	27	329	419.8	2 781	9 876	15.0
1999–00	993	25	301	352.0	2 747	10 041	16.9
2000–01	1 039	25	309	332.1	2 922	10 853	17.1
2001–02	896	28	288	271.6	2 514	8 422	25.1
2002–03	910	25	263	426.3	2 569	8 764	18.4
2003–04	945	24	257	450.9	2 556	9 537	18.8
2004–05	1 050	25	277	435.0	2 865	10 539	24.5
2005–06	1 012	26	272	506.7	2 821	10 290	25.2
2006–07	1 244	27	339	532.8	3 495	12 613	25.4
2007–08	1 029	24	307	494.1	2 699	11 441	20.5
2008–09	1 074	25	295	505.9	2 826	11 993	18.2
2009–10	1 136	25	359	514.7	3 002	11 791	19.4
2010–11	1 171	26	348	475.7	3 129	12 385	16.3
2011–12	1 059	25	329	455.2	2 756	11 192	18.1
2012–13	944	24	330	438.4	2 433	10 116	12.2
2013–14	1 058	22	361	501.3	2 787	11 541	14.0
2014–15	974	23	334	449.8	2 538	10 512	15.5
2015–16	971	23	300	495.6	2 682	10 988	13.9
2016–17	972	21	341	532.9	2 669	11 335	20.1
2017–18	749	20	258	466.1	2 069	8 947	13.5
2018–19	796	17	273	487.0	2 165	9 546	11.3
2019–20	812	18	241	441.1	2 166	9 670	14.4
2020–21	923	17	259	507.3	2 496	11 107	18.6
2021–22	892	17	254	496.0	2 437	10 987	18.4
2022–23	811	16	231	431.2	2 170	9 868	17.9
2023–24	614	13	164	310.9	1 609	7 476	17.9
2024–25	581	13	153	266.6	1 551	6 954	28.4

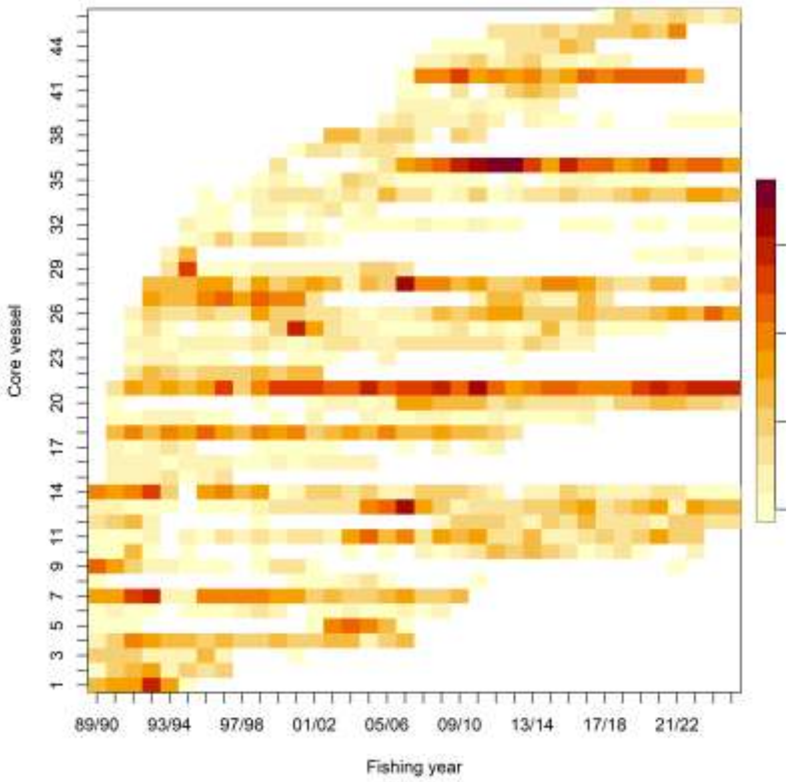

Figure A16: Annual number of daily records for each vessel included in the WCSI Trawl core fleet data set. The colour of the cell represents the number of records from low (pale yellow) to high (dark red).

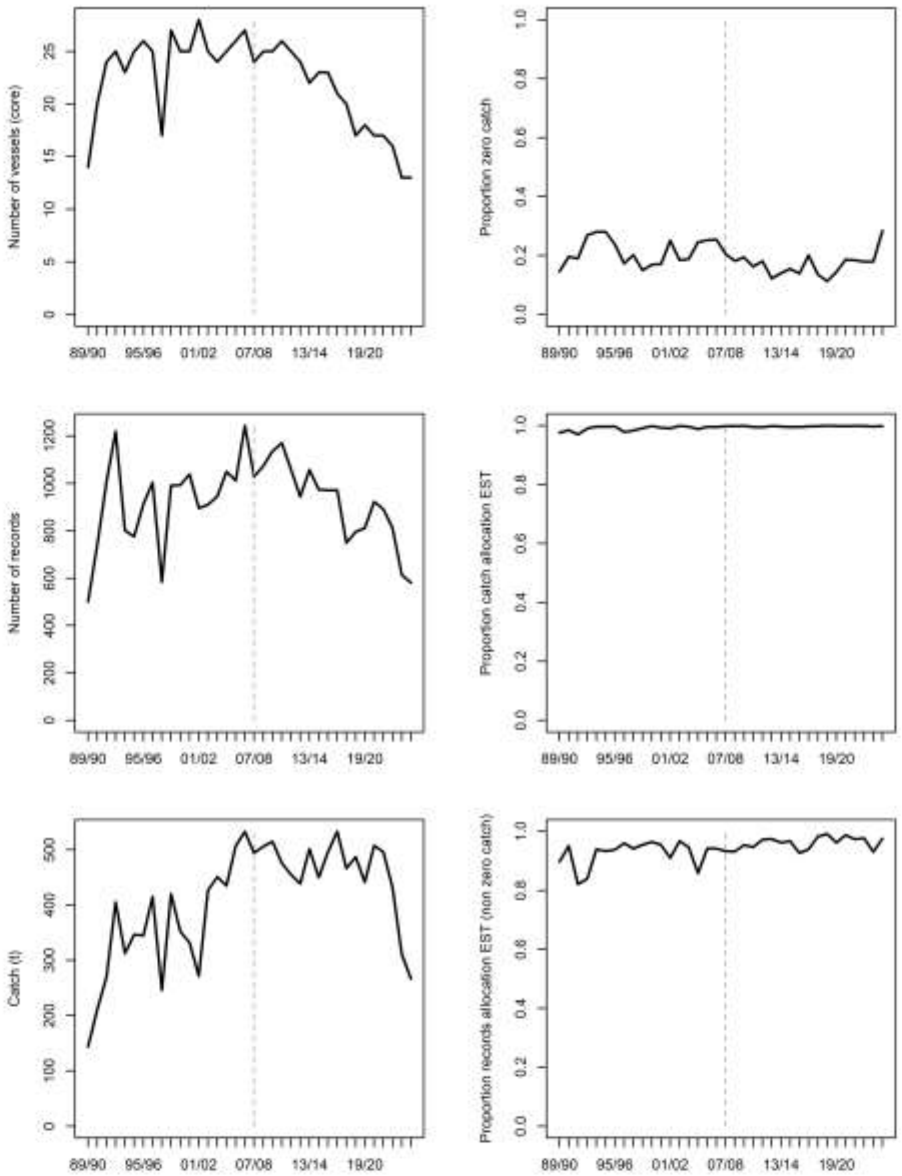

Figure A17: A summary of the data included in the WCSI Trawl CPUE data set.

Table A13: Summary of stepwise selection of variables in the WCSI Trawl positive catch CPUE model. Model terms are listed in the order of acceptance to the model.

Term	Degrees of freedom	Deviance	Residual deviance	R^2	Improvement
Null model			50 018		
FishingYear	35	2 099.8	47 918	0.042	
Vessel	45	9 692.1	38 226	0.236	19.4%
TargetSpecies	4	4 370.2	33 856	0.323	8.7%
NumTrawl	3	2 674.4	31 182	0.377	5.3%
StatArea	3	557.6	30 624	0.388	1.1%
Month	11	384.0	30 240	0.395	0.8%
Duration	3	248.4	29 992	0.400	0.5%

Table A14: Summary of stepwise selection of variables in the WCSI Trawl occurrence CPUE model. Model terms are listed in the order of acceptance to the model.

Term	Degrees of freedom	Deviance	Residual deviance	R^2	Improvement
Null model			32 541		
FishingYear	35	429.1	32 112	0.013	
TargetSpecies	4	3 991.7	28 120	0.136	12.3%
Vessel	45	610.6	27 509	0.155	1.9%
Month	11	200.6	27 309	0.161	0.6%
StatArea	3	158.3	27 150	0.166	0.5%

Table A15: WCSI Trawl CPUE indices and associated lower bound (LCI) and upper bound (UCI) of the 95% confidence intervals.

Fishing year	Combined			Binomial			Lognormal		
	Index	LCI	UCI	Index	LCI	UCI	Index	LCI	UCI
1989–90	0.852	0.739	0.978	0.854	0.808	0.893	1.000	0.877	1.130
1990–91	0.826	0.708	0.952	0.818	0.763	0.865	1.011	0.879	1.151
1991–92	0.718	0.623	0.815	0.848	0.799	0.888	0.846	0.741	0.960
1992–93	0.849	0.735	0.977	0.809	0.752	0.855	1.050	0.923	1.183
1993–94	0.787	0.672	0.919	0.765	0.698	0.824	1.029	0.893	1.175
1994–95	1.053	0.897	1.221	0.794	0.734	0.851	1.326	1.151	1.516
1995–96	0.971	0.837	1.123	0.784	0.726	0.835	1.239	1.086	1.408
1996–97	1.248	1.078	1.426	0.826	0.766	0.870	1.512	1.344	1.709
1997–98	1.325	1.122	1.552	0.814	0.751	0.864	1.628	1.415	1.879
1998–99	1.227	1.056	1.411	0.844	0.798	0.887	1.454	1.274	1.664
1999–00	1.006	0.870	1.158	0.816	0.759	0.865	1.232	1.079	1.401
2000–01	0.907	0.777	1.036	0.822	0.765	0.871	1.104	0.969	1.250
2001–02	0.783	0.668	0.903	0.789	0.726	0.841	0.992	0.858	1.130
2002–03	1.252	1.072	1.454	0.831	0.779	0.880	1.506	1.306	1.736
2003–04	1.411	1.220	1.631	0.852	0.803	0.894	1.656	1.461	1.896
2004–05	1.033	0.894	1.174	0.843	0.795	0.885	1.226	1.062	1.396
2005–06	1.253	1.075	1.452	0.795	0.735	0.846	1.576	1.381	1.807
2006–07	1.049	0.900	1.200	0.806	0.746	0.855	1.301	1.148	1.469
2007–08	1.030	0.888	1.190	0.837	0.789	0.880	1.231	1.076	1.403
2008–09	0.864	0.738	0.996	0.819	0.762	0.869	1.054	0.920	1.198
2009–10	0.860	0.730	0.995	0.772	0.703	0.827	1.114	0.980	1.262
2010–11	0.776	0.670	0.895	0.799	0.739	0.849	0.972	0.847	1.113
2011–12	0.893	0.763	1.046	0.750	0.674	0.814	1.191	1.038	1.366
2012–13	0.935	0.786	1.085	0.803	0.738	0.859	1.164	1.009	1.331
2013–14	1.023	0.876	1.190	0.809	0.752	0.859	1.265	1.105	1.434
2014–15	1.115	0.958	1.289	0.826	0.766	0.872	1.351	1.177	1.539
2015–16	1.044	0.901	1.204	0.827	0.765	0.875	1.263	1.101	1.449
2016–17	1.053	0.894	1.230	0.781	0.712	0.841	1.349	1.175	1.547
2017–18	1.150	0.984	1.343	0.788	0.712	0.847	1.459	1.275	1.667
2018–19	1.173	1.009	1.354	0.821	0.757	0.874	1.428	1.252	1.631
2019–20	1.055	0.906	1.226	0.822	0.765	0.873	1.283	1.119	1.465
2020–21	1.032	0.878	1.209	0.749	0.679	0.810	1.378	1.208	1.574
2021–22	0.985	0.827	1.150	0.748	0.674	0.813	1.317	1.137	1.498
2022–23	0.760	0.630	0.894	0.691	0.606	0.769	1.099	0.949	1.255
2023–24	0.619	0.507	0.738	0.685	0.595	0.765	0.905	0.781	1.046
2024–25	0.711	0.563	0.865	0.602	0.511	0.687	1.181	1.014	1.370

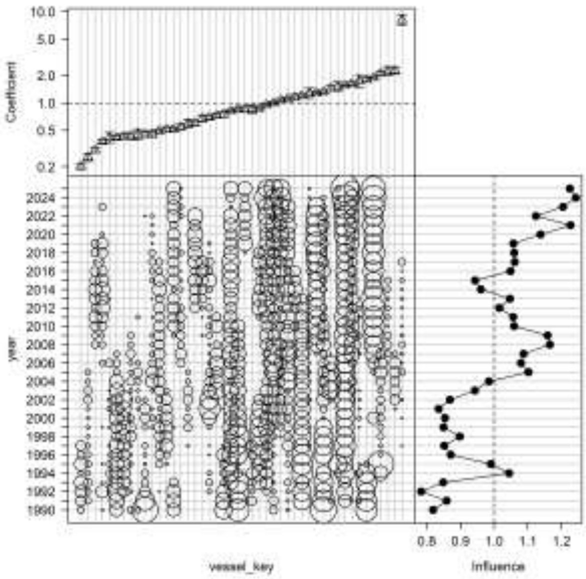

Figure A18: Influence plot of the Vessel variable in the WCSI Trawl positive catch CPUE model.

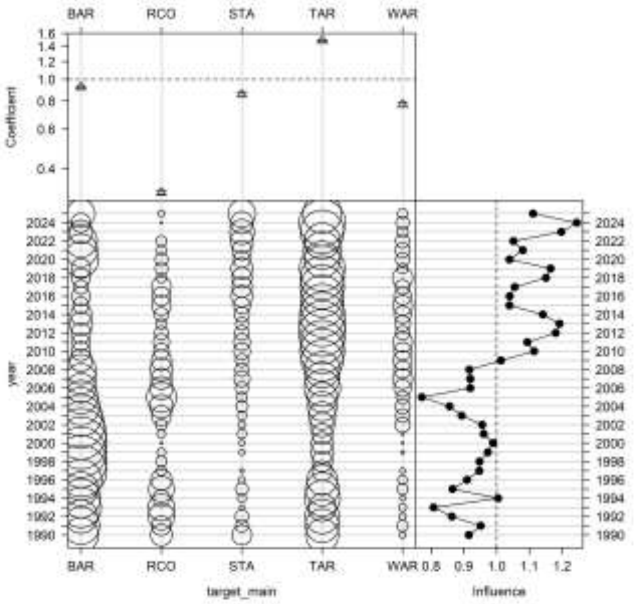

Figure A19: Influence plot of the Target Species variable in the WCSI Trawl positive catch CPUE model.

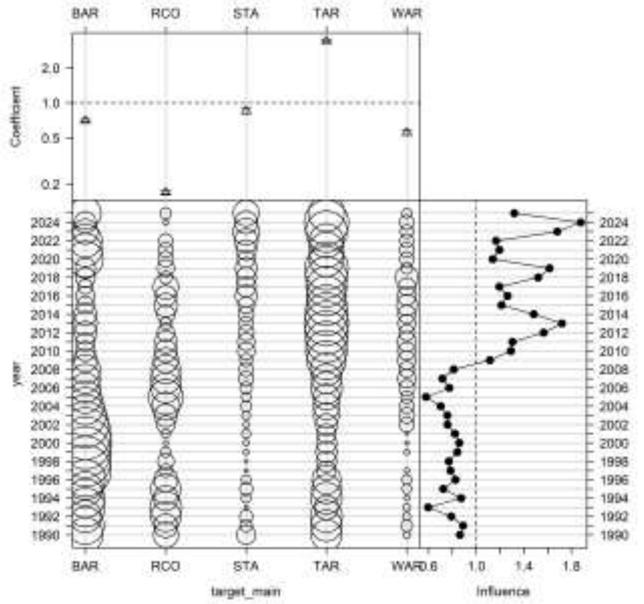

Figure A20: Influence plot of the Target Species variable in the WCSI Trawl occurrence CPUE model.

APPENDIX 4: STOCK ASSESSMENT INPUTS

Table A16: Fishery catches (t) included in the assessment model, including allowances for unreported catches.

Year	Fishery			
	WCSI	TBGB	TAR 8	WCNI
1932	0.0	0.0	2.4	1.2
1933	1.2	0.0	2.4	1.2
1934	1.8	0.0	1.2	0.0
1935	0.0	0.0	2.4	1.2
1936	0.0	0.0	2.4	0.0
1937	1.2	0.0	0.0	0.0
1938	1.2	0.0	0.0	0.0
1939	4.9	0.0	0.0	0.0
1940	5.4	0.0	0.0	0.0
1941	0.6	0.0	0.0	0.0
1942	0.6	0.0	0.0	0.0
1943	0.6	0.0	0.0	0.0
1944	1.2	0.0	0.0	0.0
1945	0.0	0.0	0.0	0.0
1946	0.0	0.0	0.0	0.0
1947	0.0	0.0	2.4	0.0
1948	18.9	26.5	2.4	0.0
1949	22.9	35.6	10.8	2.4
1950	33.0	7.5	15.6	2.4
1951	64.4	0.0	9.6	1.2
1952	36.8	0.0	8.4	1.2
1953	19.1	0.0	9.6	2.4
1954	9.1	1.2	24.0	172.8
1955	5.6	3.9	86.4	21.6
1956	7.0	1.7	100.8	254.4
1957	6.3	0.0	33.6	339.6
1958	8.4	0.0	21.6	220.8
1959	26.7	6.8	24.0	258.0
1960	51.8	5.0	20.4	220.8
1961	28.7	6.7	18.0	192.0
1962	26.1	3.7	27.6	184.8
1963	8.2	5.9	62.4	180.0
1964	8.2	8.8	51.6	261.6
1965	25.1	10.4	73.2	168.0
1966	19.4	4.2	69.6	72.0
1967	53.9	7.6	76.8	106.8
1968	105.2	1 599.5	87.6	180.0
1969	56.6	1 603.2	122.4	94.8
1970	120.6	95.2	207.6	129.6
1971	208.5	764.3	183.6	256.8
1972	156.3	627.9	242.4	327.6
1973	85.3	314.3	334.8	249.6
1974	31.0	293.6	226.8	190.8
1975	224.4	506.1	230.4	166.8
1976	348.9	222.2	284.4	114.0
1977	198.1	339.7	344.4	128.4
1978	245.5	549.5	556.8	213.6
1979	246.0	526.4	271.2	126.0
1980	351.3	409.2	130.8	247.2
1981	152.6	302.1	130.8	398.4
1982	334.1	675.3	200.4	308.4
1983	408.5	354.9	181.2	276.0
1984	547.3	183.9	130.8	306.7
1985	363.8	108.6	122.4	163.5
1986	173.1	94.4	146.4	169.1
1987	479.5	152.6	222.0	218.3
1988	445.5	141.8	236.4	261.6
1989	334.2	106.4	145.2	225.0
1990	558.4	83.4	125.4	281.7
1991	572.0	80.0	209.0	222.3
1992	760.5	61.5	207.9	262.1
1993	556.9	14.5	144.1	392.3
1994	549.8	155.8	210.1	318.4
1995	662.3	184.4	188.1	424.6
1996	637.9	89.0	115.5	495.6
1997	800.7	65.8	146.3	463.3
1998	414.8	62.7	168.3	470.1
1999	758.9	74.1	192.5	519.3
2000	631.7	111.6	207.9	549.8
2001	664.4	160.8	195.8	446.7
2002	596.9	100.8	245.3	416.0
2003	859.9	94.3	232.1	452.7
2004	853.4	88.8	216.7	397.1
2005	883.3	75.1	202.4	424.8
2006	1 018.3	50.9	313.5	342.4
2007	982.5	78.5	279.4	411.2
2008	927.7	67.2	215.6	520.6
2009	879.2	47.0	185.9	467.8
2010	989.3	73.6	259.6	328.0
2011	798.3	110.5	213.4	429.5
2012	826.7	209.6	258.5	344.4
2013	788.0	156.4	229.9	507.2
2014	869.5	99.1	272.8	614.9
2015	793.4	73.8	246.4	628.0
2016	880.0	110.6	261.8	505.5
2017	896.2	64.6	231.0	560.1
2018	836.6	84.3	236.5	514.1
2019	860.3	82.0	267.3	421.9
2020	782.3	82.8	227.7	404.7
2021	851.9	100.0	240.9	498.4
2022	804.6	88.6	199.1	444.3
2023	771.6	66.4	222.2	312.2
2024	560.5	32.4	258.5	230.9
2025	456.6	71.0	267.3	357.4

Table A17: Proportional age compositions for WCSI commercial fishery.

Age	Females						Males					
	2005	2007	2019	2020	2024	2025	2005	2007	2019	2020	2024	2025
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3	0.0027	0.0009	0.0000	0.0000	0.0000	0.0000	0.0000	0.0027	0.0000	0.0000	0.0000	0.0000
4	0.0106	0.0120	0.0097	0.0054	0.0029	0.0000	0.0078	0.0080	0.0139	0.0039	0.0000	0.0025
5	0.0810	0.0301	0.0843	0.0517	0.0203	0.0049	0.0485	0.0155	0.0530	0.0613	0.0078	0.0090
6	0.0743	0.0440	0.0364	0.0683	0.0781	0.0222	0.1062	0.0297	0.0387	0.1018	0.0662	0.0281
7	0.0748	0.1233	0.0568	0.0327	0.0897	0.1264	0.0833	0.0995	0.0715	0.0359	0.0562	0.0874
8	0.0592	0.1389	0.1444	0.0526	0.0468	0.0749	0.0768	0.0697	0.1545	0.0403	0.0361	0.0680
9	0.0507	0.0612	0.0293	0.1106	0.0643	0.0339	0.0377	0.0312	0.0107	0.1094	0.0571	0.0380
10	0.0270	0.0548	0.0378	0.0271	0.0556	0.0766	0.0201	0.0274	0.0195	0.0188	0.0655	0.0393
11	0.0287	0.0343	0.0358	0.0172	0.0172	0.0507	0.0306	0.0361	0.0458	0.0207	0.0099	0.0440
12	0.0167	0.0142	0.0346	0.0364	0.0387	0.0120	0.0122	0.0051	0.0303	0.0156	0.0201	0.0140
13	0.0139	0.0226	0.0035	0.0523	0.0444	0.0143	0.0080	0.0198	0.0101	0.0470	0.0252	0.0147
14	0.0107	0.0039	0.0126	0.0060	0.0033	0.0357	0.0033	0.0012	0.0102	0.0071	0.0058	0.0311
15	0.0129	0.0066	0.0031	0.0087	0.0182	0.0080	0.0180	0.0030	0.0018	0.0117	0.0089	0.0046
16	0.0056	0.0086	0.0020	0.0038	0.0329	0.0016	0.0053	0.0073	0.0000	0.0010	0.0161	0.0079
17	0.0016	0.0042	0.0000	0.0014	0.0199	0.0258	0.0045	0.0072	0.0000	0.0000	0.0210	0.0102
18	0.0079	0.0092	0.0037	0.0066	0.0112	0.0167	0.0000	0.0050	0.0015	0.0011	0.0082	0.0123
19	0.0032	0.0020	0.0057	0.0018	0.0034	0.0075	0.0013	0.0013	0.0025	0.0015	0.0078	0.0000
20	0.0046	0.0014	0.0007	0.0068	0.0022	0.0095	0.0044	0.0014	0.0045	0.0030	0.0000	0.0194
21	0.0065	0.0030	0.0000	0.0056	0.0000	0.0036	0.0022	0.0047	0.0020	0.0050	0.0000	0.0016
22	0.0021	0.0019	0.0036	0.0014	0.0045	0.0000	0.0013	0.0036	0.0000	0.0010	0.0000	0.0031
23	0.0016	0.0049	0.0049	0.0000	0.0000	0.0013	0.0032	0.0014	0.0057	0.0028	0.0022	0.0000
24	0.0059	0.0021	0.0017	0.0000	0.0110	0.0035	0.0021	0.0000	0.0000	0.0019	0.0000	0.0031
25	0.0030	0.0018	0.0000	0.0000	0.0037	0.0015	0.0000	0.0000	0.0000	0.0018	0.0025	0.0066
26	0.0020	0.0034	0.0000	0.0014	0.0026	0.0052	0.0020	0.0018	0.0020	0.0000	0.0000	0.0016
27	0.0000	0.0039	0.0032	0.0000	0.0000	0.0016	0.0000	0.0000	0.0000	0.0025	0.0000	0.0000
28	0.0008	0.0025	0.0000	0.0014	0.0023	0.0013	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
29	0.0000	0.0012	0.0018	0.0000	0.0032	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0044
30+	0.0025	0.0079	0.0035	0.0026	0.0047	0.0047	0.0026	0.0108	0.0029	0.0029	0.0023	0.0057

Table A18: Proportional age compositions for TAR 8 commercial fishery.

Age	Females				Males			
	2019	2020	2024	2025	2019	2020	2024	2025
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3	0.0110	0.0018	0.0000	0.0000	0.0048	0.0000	0.0000	0.0000
4	0.1417	0.0118	0.0000	0.0012	0.1444	0.0128	0.0012	0.0028
5	0.1038	0.1357	0.0144	0.0000	0.0967	0.1322	0.0274	0.0013
6	0.0174	0.0870	0.0144	0.0084	0.0249	0.0909	0.0334	0.0115
7	0.0528	0.0093	0.0257	0.0175	0.0183	0.0201	0.0468	0.0285
8	0.0541	0.0222	0.0150	0.0198	0.0428	0.0399	0.0407	0.0440
9	0.0284	0.0389	0.0431	0.0133	0.0131	0.0797	0.1302	0.0284
10	0.0128	0.0167	0.0491	0.0611	0.0122	0.0288	0.0807	0.1283
11	0.0363	0.0097	0.0133	0.0494	0.0081	0.0239	0.0203	0.0541
12	0.0359	0.0331	0.0163	0.0180	0.0370	0.0411	0.0110	0.0246
13	0.0050	0.0238	0.0295	0.0339	0.0066	0.0541	0.0411	0.0235
14	0.0105	0.0106	0.0208	0.0310	0.0081	0.0126	0.0273	0.0503
15	0.0000	0.0032	0.0009	0.0247	0.0081	0.0118	0.0213	0.0204
16	0.0055	0.0000	0.0267	0.0239	0.0000	0.0008	0.0495	0.0130
17	0.0081	0.0012	0.0355	0.0258	0.0027	0.0000	0.0556	0.0315
18	0.0041	0.0019	0.0061	0.0381	0.0000	0.0059	0.0097	0.0388
19	0.0050	0.0105	0.0047	0.0182	0.0041	0.0000	0.0137	0.0198
20	0.0013	0.0007	0.0026	0.0214	0.0000	0.0000	0.0030	0.0245
21	0.0000	0.0059	0.0028	0.0084	0.0013	0.0000	0.0151	0.0012
22	0.0066	0.0019	0.0002	0.0013	0.0000	0.0015	0.0052	0.0000
23	0.0091	0.0043	0.0024	0.0028	0.0122	0.0000	0.0026	0.0043
24	0.0027	0.0007	0.0049	0.0013	0.0000	0.0000	0.0034	0.0022
25	0.0000	0.0059	0.0000	0.0074	0.0000	0.0000	0.0000	0.0022
26	0.0000	0.0025	0.0026	0.0000	0.0000	0.0000	0.0000	0.0036
27	0.0000	0.0000	0.0038	0.0013	0.0000	0.0046	0.0069	0.0023
28	0.0000	0.0000	0.0052	0.0056	0.0013	0.0000	0.0044	0.0000
29	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0027	0.0000
30+	0.0013	0.0000	0.0068	0.0027	0.0000	0.0000	0.0000	0.0022

Table A19: Proportional age compositions for WCNI commercial fishery.

Age	Females						Males					
	2014	2015	2019	2020	2024	2025	2014	2015	2019	2020	2024	2025
1	0.000	0.000	0.000	0.000	0.000	0.000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3	0.005	0.020	0.000	0.002	0.000	0.000	0.0030	0.0010	0.0000	0.0028	0.0037	0.0052
4	0.006	0.013	0.021	0.003	0.000	0.001	0.0110	0.0230	0.0384	0.0077	0.0000	0.0089
5	0.018	0.029	0.034	0.038	0.008	0.002	0.0470	0.0310	0.0553	0.0442	0.0015	0.0061
6	0.064	0.039	0.032	0.060	0.012	0.033	0.0630	0.0340	0.0260	0.0937	0.0008	0.0467
7	0.110	0.098	0.040	0.048	0.026	0.018	0.1220	0.0700	0.0806	0.0392	0.0344	0.0295
8	0.039	0.123	0.074	0.039	0.026	0.047	0.0270	0.0880	0.1444	0.0644	0.0481	0.0357
9	0.080	0.052	0.031	0.077	0.119	0.042	0.0480	0.0290	0.0501	0.0796	0.1433	0.0257
10	0.041	0.053	0.020	0.025	0.069	0.107	0.0140	0.0450	0.0348	0.0237	0.0542	0.0914
11	0.033	0.019	0.038	0.035	0.021	0.067	0.0160	0.0140	0.0319	0.0289	0.0376	0.0515
12	0.030	0.019	0.037	0.030	0.027	0.018	0.0240	0.0080	0.0260	0.0223	0.0313	0.0186
13	0.018	0.029	0.024	0.042	0.039	0.032	0.0130	0.0120	0.0226	0.0113	0.0464	0.0146
14	0.023	0.009	0.024	0.018	0.016	0.053	0.0070	0.0020	0.0161	0.0169	0.0215	0.0221
15	0.008	0.028	0.001	0.011	0.018	0.018	0.0130	0.0100	0.0093	0.0168	0.0180	0.0073
16	0.006	0.010	0.003	0.009	0.028	0.027	0.0060	0.0080	0.0039	0.0016	0.0070	0.0174
17	0.025	0.010	0.011	0.005	0.023	0.031	0.0050	0.0050	0.0042	0.0065	0.0121	0.0066
18	0.017	0.021	0.005	0.008	0.009	0.022	0.0080	0.0020	0.0000	0.0072	0.0077	0.0070
19	0.009	0.010	0.006	0.005	0.008	0.005	0.0010	0.0110	0.0047	0.0015	0.0000	0.0074
20	0.010	0.001	0.003	0.002	0.007	0.007	0.0030	0.0030	0.0023	0.0015	0.0059	0.0045
21	0.007	0.006	0.007	0.001	0.006	0.004	0.0010	0.0030	0.0010	0.0000	0.0038	0.0042
22	0.004	0.005	0.003	0.006	0.003	0.010	0.0020	0.0010	0.0125	0.0106	0.0018	0.0000
23	0.001	0.000	0.003	0.007	0.002	0.004	0.0000	0.0020	0.0034	0.0049	0.0042	0.0016
24	0.006	0.007	0.001	0.007	0.004	0.001	0.0000	0.0030	0.0007	0.0051	0.0043	0.0011
25	0.000	0.004	0.005	0.002	0.007	0.009	0.0010	0.0010	0.0030	0.0034	0.0017	0.0052
26	0.000	0.000	0.000	0.011	0.001	0.006	0.0000	0.0000	0.0010	0.0027	0.0013	0.0000
27	0.001	0.002	0.001	0.002	0.001	0.001	0.0010	0.0000	0.0000	0.0000	0.0024	0.0018
28	0.000	0.000	0.001	0.002	0.000	0.004	0.0000	0.0000	0.0000	0.0025	0.0041	0.0021
29	0.002	0.000	0.002	0.000	0.001	0.003	0.0000	0.0000	0.0000	0.0035	0.0014	0.0000
30+	0.000	0.002	0.002	0.000	0.009	0.005	0.0000	0.0010	0.0000	0.0019	0.0000	0.0027

Table A20: Proportional age compositions for WCNI trawl survey.

Age	Females				Males			
	2019	2020	2021	2023	2019	2020	2021	2023
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
4	0.0153	0.0000	0.0042	0.0000	0.0507	0.0044	0.0000	0.0000
5	0.0477	0.0675	0.0000	0.0000	0.0444	0.0707	0.0077	0.0213
6	0.0178	0.0814	0.0346	0.0128	0.0583	0.0606	0.0879	0.0390
7	0.0611	0.0398	0.0522	0.0369	0.0046	0.0448	0.0647	0.0644
8	0.1159	0.1120	0.0274	0.1782	0.0886	0.0318	0.0244	0.1302
9	0.0440	0.0815	0.0699	0.0774	0.1117	0.0963	0.0138	0.1084
10	0.0944	0.0346	0.0674	0.0128	0.0411	0.0073	0.1022	0.0000
11	0.0507	0.0440	0.0237	0.0128	0.0107	0.0125	0.0548	0.0316
12	0.0139	0.0060	0.0280	0.0000	0.0189	0.0242	0.0179	0.0203
13	0.0070	0.0530	0.0362	0.0538	0.0000	0.0033	0.0276	0.0143
14	0.0229	0.0126	0.0286	0.0000	0.0036	0.0091	0.0419	0.0000
15	0.0082	0.0113	0.0342	0.0062	0.0000	0.0000	0.0054	0.0000
16	0.0059	0.0000	0.0124	0.0295	0.0000	0.0063	0.0211	0.0416
17	0.0248	0.0132	0.0106	0.0000	0.0011	0.0000	0.0000	0.0146
18	0.0000	0.0000	0.0000	0.0000	0.0000	0.0107	0.0104	0.0000
19	0.0000	0.0096	0.0219	0.0000	0.0013	0.0000	0.0000	0.0213
20	0.0000	0.0126	0.0199	0.0000	0.0000	0.0000	0.0000	0.0443
21	0.0058	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
22	0.0000	0.0000	0.0093	0.0000	0.0000	0.0000	0.0000	0.0000
23	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
24	0.0000	0.0113	0.0000	0.0000	0.0011	0.0000	0.0000	0.0000
25	0.0082	0.0000	0.0000	0.0281	0.0000	0.0000	0.0000	0.0000
26	0.0088	0.0000	0.0163	0.0000	0.0000	0.0000	0.0000	0.0000
27	0.0000	0.0275	0.0128	0.0000	0.0000	0.0000	0.0000	0.0000
28	0.0055	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
29	0.0059	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
30+	0.0000	0.0000	0.0106	0.0000	0.0000	0.0000	0.0000	0.0000

Table A21: Proportional age compositions of female tarakihi for the WCSI trawl survey.

Age													Females
	2000	2003	2005	2007	2009	2011	2013	2015	2017	2019	2021	2023	2025
1	0.0056	0.0006	0.0000	0.0000	0.0000	0.0003	0.0024	0.0057	0.0000	0.0031	0.0000	0.0222	0.0013
2	0.0865	0.0011	0.0016	0.0060	0.0067	0.0236	0.0337	0.0056	0.0030	0.0144	0.0000	0.0154	0.1210
3	0.0877	0.0368	0.0004	0.0038	0.0207	0.1331	0.0023	0.0210	0.0579	0.0058	0.0007	0.0000	0.0233
4	0.0980	0.0226	0.0215	0.0172	0.0912	0.0550	0.0171	0.0421	0.0231	0.0999	0.0156	0.0052	0.0041
5	0.0127	0.0240	0.1309	0.0274	0.0156	0.1152	0.1192	0.0469	0.0464	0.1192	0.0142	0.0552	0.0055
6	0.0929	0.0519	0.0768	0.0182	0.0459	0.0595	0.1881	0.0190	0.1040	0.0303	0.0619	0.0472	0.0282
7	0.0474	0.0126	0.1013	0.2257	0.0310	0.0111	0.0315	0.1259	0.0243	0.0382	0.0831	0.0223	0.0920
8	0.0289	0.0281	0.0697	0.0565	0.0301	0.0163	0.0853	0.1784	0.0471	0.1430	0.0294	0.0902	0.0609
9	0.0568	0.0654	0.0400	0.0104	0.0893	0.0099	0.0110	0.0337	0.0544	0.0215	0.0415	0.1129	0.0127
10	0.0183	0.0139	0.0302	0.0702	0.0559	0.0129	0.0141	0.0517	0.0687	0.0188	0.1132	0.0384	0.0513
11	0.0181	0.0300	0.0288	0.0152	0.0238	0.0426	0.0168	0.0086	0.0249	0.0417	0.0236	0.0165	0.0555
12	0.0048	0.0261	0.0153	0.0033	0.0330	0.0226	0.0057	0.0079	0.0303	0.0458	0.0101	0.0783	0.0095
13	0.0000	0.0288	0.0086	0.0292	0.0141	0.0138	0.0375	0.0021	0.0052	0.0102	0.0553	0.0108	0.0083
14	0.0190	0.0000	0.0323	0.0076	0.0032	0.0085	0.0250	0.0000	0.0040	0.0209	0.0529	0.0138	0.0445
15	0.0304	0.0199	0.0367	0.0116	0.0158	0.0097	0.0080	0.0178	0.0016	0.0019	0.0104	0.0442	0.0136
16	0.0025	0.0199	0.0063	0.0094	0.0000	0.0054	0.0086	0.0198	0.0093	0.0047	0.0115	0.0339	0.0099
17	0.0047	0.0000	0.0000	0.0024	0.0027	0.0023	0.0052	0.0051	0.0050	0.0000	0.0070	0.0235	0.0278
18	0.0000	0.0293	0.0005	0.0000	0.0097	0.0011	0.0085	0.0107	0.0152	0.0041	0.0020	0.0109	0.0271
19	0.0076	0.0060	0.0011	0.0000	0.0007	0.0000	0.0091	0.0000	0.0022	0.0104	0.0066	0.0031	0.0035
20	0.0047	0.0158	0.0000	0.0021	0.0000	0.0000	0.0000	0.0056	0.0076	0.0047	0.0331	0.0190	0.0050
21	0.0025	0.0000	0.0005	0.0033	0.0014	0.0017	0.0019	0.0032	0.0021	0.0124	0.0000	0.0000	0.0000
22	0.0000	0.0000	0.0000	0.0019	0.0000	0.0039	0.0031	0.0018	0.0000	0.0056	0.0000	0.0000	0.0016
23	0.0017	0.0000	0.0000	0.0045	0.0007	0.0012	0.0000	0.0021	0.0035	0.0000	0.0000	0.0000	0.0000
24	0.0000	0.0000	0.0027	0.0015	0.0092	0.0010	0.0000	0.0023	0.0021	0.0009	0.0000	0.0000	0.0000
25	0.0000	0.0000	0.0000	0.0000	0.0020	0.0000	0.0019	0.0018	0.0000	0.0074	0.0000	0.0000	0.0000
26	0.0000	0.0000	0.0076	0.0000	0.0000	0.0000	0.0000	0.0013	0.0000	0.0019	0.0000	0.0000	0.0016
27	0.0020	0.0000	0.0000	0.0012	0.0000	0.0000	0.0000	0.0000	0.0026	0.0000	0.0000	0.0000	0.0032
28	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0018
29	0.0000	0.0000	0.0014	0.0000	0.0000	0.0000	0.0055	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
30+	0.0047	0.0024	0.0034	0.0075	0.0046	0.0018	0.0019	0.0000	0.0077	0.0009	0.0000	0.0000	0.0006

Table A22: Proportional age compositions of male tarakihi for the WCSI trawl survey.

Age													Males
	2000	2003	2005	2007	2009	2011	2013	2015	2017	2019	2021	2023	2025
1	0.0089	0.0009	0.0000	0.0019	0.0000	0.0080	0.0078	0.0120	0.0006	0.0024	0.0025	0.0176	0.0039
2	0.0685	0.0051	0.0005	0.0030	0.0084	0.0524	0.0468	0.0049	0.0007	0.0252	0.0000	0.0406	0.1213
3	0.0348	0.0091	0.0028	0.0034	0.0599	0.0811	0.0055	0.0318	0.0679	0.0041	0.0014	0.0011	0.0175
4	0.0956	0.0318	0.0193	0.0172	0.0671	0.1213	0.0215	0.0391	0.0222	0.1427	0.0068	0.0081	0.0037
5	0.0162	0.0311	0.1466	0.0263	0.0272	0.0503	0.1185	0.0105	0.0608	0.0494	0.0140	0.0281	0.0078
6	0.0356	0.0812	0.0935	0.0380	0.0137	0.0590	0.0919	0.0094	0.1069	0.0083	0.0906	0.0520	0.0234
7	0.0064	0.0221	0.0351	0.1537	0.0451	0.0056	0.0092	0.0729	0.0127	0.0199	0.1117	0.0254	0.0768
8	0.0220	0.0280	0.0171	0.0559	0.0391	0.0055	0.0271	0.0719	0.0203	0.0409	0.0113	0.0337	0.0404
9	0.0201	0.0806	0.0218	0.0342	0.0462	0.0054	0.0010	0.0167	0.0447	0.0037	0.0238	0.0331	0.0065
10	0.0149	0.0123	0.0059	0.0000	0.0542	0.0042	0.0013	0.0399	0.0549	0.0016	0.0330	0.0102	0.0259
11	0.0124	0.0519	0.0038	0.0051	0.0264	0.0067	0.0010	0.0035	0.0062	0.0028	0.0094	0.0218	0.0228
12	0.0052	0.0385	0.0012	0.0148	0.0062	0.0053	0.0016	0.0019	0.0012	0.0034	0.0062	0.0227	0.0034
13	0.0000	0.0067	0.0052	0.0318	0.0078	0.0008	0.0025	0.0000	0.0010	0.0010	0.0425	0.0000	0.0026
14	0.0000	0.0282	0.0073	0.0012	0.0090	0.0024	0.0021	0.0054	0.0000	0.0059	0.0366	0.0088	0.0142
15	0.0059	0.0195	0.0065	0.0071	0.0129	0.0008	0.0011	0.0025	0.0007	0.0000	0.0051	0.0134	0.0020
16	0.0000	0.0000	0.0025	0.0000	0.0000	0.0000	0.0006	0.0026	0.0007	0.0000	0.0174	0.0109	0.0023
17	0.0013	0.0000	0.0000	0.0008	0.0080	0.0004	0.0026	0.0058	0.0051	0.0000	0.0000	0.0000	0.0056
18	0.0000	0.0000	0.0009	0.0000	0.0078	0.0000	0.0003	0.0013	0.0013	0.0000	0.0000	0.0096	0.0039
19	0.0000	0.0247	0.0040	0.0000	0.0046	0.0000	0.0018	0.0014	0.0019	0.0010	0.0000	0.0000	0.0005
20	0.0013	0.0000	0.0020	0.0002	0.0012	0.0001	0.0000	0.0010	0.0000	0.0000	0.0139	0.0000	0.0008
21	0.0004	0.0054	0.0000	0.0000	0.0000	0.0000	0.0006	0.0000	0.0010	0.0000	0.0000	0.0000	0.0000
22	0.0006	0.0000	0.0000	0.0016	0.0000	0.0000	0.0006	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
23	0.0000	0.0164	0.0009	0.0004	0.0000	0.0000	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
24	0.0000	0.0000	0.0022	0.0000	0.0000	0.0000	0.0007	0.0000	0.0007	0.0000	0.0000	0.0000	0.0000
25	0.0000	0.0000	0.0009	0.0000	0.0016	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
26	0.0000	0.0000	0.0000	0.0000	0.0000	0.0005	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002
27	0.0029	0.0182	0.0010	0.0000	0.0000	0.0006	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002
28	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003
29	0.0000	0.0000	0.0000	0.0077	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
30+	0.0053	0.0036	0.0000	0.0008	0.0012	0.0005	0.0008	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000