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Stock assessment of trevally in TRE 7 for 2026

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TABLE OF CONTENTS

EXECUTIVE SUMMARY **1**

1. INTRODUCTION **2**

2. COMMERCIAL FISHERY CHARACTERISATION **2**
2.1 Data set 2
2.2 Recent trends 5

3. CPUE ANALYSIS **13**
3.1 Ninety Mile Beach 15
3.2 Kaipara-Manukau and North Taranaki Bight 17
3.3 South Taranaki Bight 18
3.4 Comparisons between areas 20

4. DATA COMPILATION **21**
4.1 Commercial catch history 21
4.2 Age Compositions 24
4.3 Age and growth 27
4.4 Trawl survey data 29

5. STOCK ASSESSMENT **30**
5.1 Stock structure 30
5.2 Model structure 30
5.3 Parameter estimates 32
5.4 Diagnostics 34
5.5 Stock dynamics 43
5.6 Stock status 45
5.7 Comparative model using Casal2 49

6. DISCUSSION **49**

7. ACKNOWLEDGMENTS **51**

8. REFERENCES **51**

APPENDIX 1: CPUE DATA ANALYSIS – NINETY MILE BEACH **53**

APPENDIX 2: CPUE ANALYSIS - KAIPARA-MANUKAU-NORTH TARANAKI BIGHT **60**

APPENDIX 3: CPUE ANALYSIS - SOUTH TARANAKI BIGHT **68**

APPENDIX 4: ASSESSMENT MODEL CATCH HISTORY **75**

PLAIN LANGUAGE SUMMARY

The trevally catch from TRE 7 is predominantly taken by the inshore trawl fishery along the west coast of the North Island. Recent catches have declined due to operational changes in the fishery.

The stock assessment for TRE 7 was updated and refined for 2026, incorporating the recent annual commercial and recreational catches, length and age compositions, commercial CPUE indices and *Kaharoa* trawl survey indices.

The base assessment model estimates that spawning biomass was maintained at about the default target biomass level (40% SB_0) during the 1980s and 1990s. From 2000, spawning biomass increased to above the target level and current (2024–25) biomass (SB_{2025}) is estimated to be well above the target. The current level of fishing mortality is estimated to be well below the reference ($F_{SB40\%}$) level.

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Trevally (*Pseudocaranx dentex*) represents a major component of the catch from the inshore fishery off the west coast of the North Island. Reported landings from the fishery peaked in the late 1970s and early 1980s at 2500–3000 t. Catches were reduced considerably in the late 1980s. During the late 1990s and 2000s, catches fluctuated about a level slightly below the TACC of 2153 t.

Over the last decade, catches from the TRE 7 commercial fishery have declined. The decline in catch appears to be related to a decline in the targeting of trevally since 2011–12, as indicated by the reduction in trawl effort in the core area of the trevally trawl fishery. These changes correspond with an increase in the abundance of snapper off the west coast of the North Island (SNA 8) since the late 2000s. Snapper are caught in association with trevally, particularly during November-December. Consequently, the limited availability of SNA 8 ACE is likely to have increasingly constrained the ability of the trawl fleet to target trevally. Since 2011–12, the trevally target fishery was dominated by a single larger vessel. The retirement of this vessel from the fishery in 2023–24 contributed to a further decline in the trevally catch in the most recent years.

The current stock assessment represents an update and refinement of the previous TRE 7 assessment. The current assessment extended the time-series of data, with the updated CPUE indices and commercial age composition data from 2022–23 and 2023–24. The main changes to the structural assumptions of the model were: the initialisation of the model in 1975 under exploited conditions and the reconfiguration of the data from the single trawl fishery (removing the partitioning of the dominant vessel in the fleet).

The base assessment model estimates that spawning biomass was maintained at about the default target biomass level (40% SB_0) during the 1980s and 1990s. From 2000, spawning biomass increased to above the target level and current (2024–25) biomass (SB_{2025}) is estimated to be well above the target. The current level of fishing mortality is estimated to be well below the reference ($F_{SB40\%}$) level.

The base assessment model encompasses the northern area of TRE 7 only. Since 2003–04, the northern area accounted for about 85% of the annual TRE 7 catches. The main conclusions of the stock assessment pertain to this portion of the fishery. The recent age composition data indicated emerging differences in stock structure between the northern area and the southern portion of TRE 7, specifically the presence of a very strong 2018 year class in the South Taranaki Bight fishery. This suggests that there are local scale processes in the South Taranaki Bight that are influencing the recruitment of trevally in the area. At this stage, there are insufficient data available to reliably assess the southern portion of the TRE 7 stock, although age composition data and CPUE indices indicate that the abundance of trevally in the south has increased since 2020–21.

1. INTRODUCTION

Trevally (*Pseudocaranx dentex*) represents a major component of the catch from the inshore fishery off the west coast of the North Island. This area accounts for almost all of the TRE 7 catch with a small proportion of the TRE 7 catch taken off the west coast of the South Island. Reported landings from the fishery peaked in the late 1970s and early 1980s at 2500–3000 t. Catches were reduced considerably in the late 1980s. During the late 1990s and 2000s, catches fluctuated about a level slightly below the TACC of 2153 t. Since 2015–16, annual catches have tended to decline, reaching an average of 1194 t in recent years (2021–22 to 2024–25) (Fisheries New Zealand 2025).

The first quantitative stock assessment of TRE 7 was conducted by Hanchet (1999) and this has been updated and refined in subsequent assessments (Maunder & Langley 2002, McKenzie 2008, Langley & Maunder 2009, Langley et al. 2015). The assessments of TRE 7 have been principally based on the time series of annual commercial catches, standardised CPUE indices and age composition data from the commercial trawl fishery. Successive assessments have incorporated the more recent CPUE (e.g. Kendrick & Bentley 2010) and age composition data from the fishery.

The ongoing sampling of commercial catches has revealed considerable differences in the age composition of trevally within TRE 7, specifically between Ninety Mile Beach, Kaipara-Manukau and North Taranaki Bight and South Taranaki Bight (Walsh et al. 2012, Walsh et al. 2014, Armiger et al. 2025) (Figure 1). There are also differences in the trends in the CPUE indices amongst the sub-areas of TRE 7 (this study). These observations indicate a degree of spatial structure of the trevally population within the TRE 7 Fishstock.

The previous stock assessment of TRE 7 included data to the end of the 2013–14 fishing year (Langley et al. 2015). The provision of age composition data from the commercial fishery for 2022–23 and 2023–34 (Armiger et al. 2025) enabled an update of the stock assessment.

The assessment was conducted under the Fisheries New Zealand research project TRE2025-01. The principal objective of the project was "to conduct a stock assessment for trevally in TRE 7, including estimating biomass and sustainable yields". This report summarises recent trends in the TRE 7 commercial fishery and updates the standardised CPUE indices and stock assessment modelling to 2024–25.

2. COMMERCIAL FISHERY CHARACTERISATION

Trends in catch and effort from the TRE 7 fishery have been described in previous reports (Kendrick & Bentley 2010, Langley et al. 2015). This section updates previous analyses incorporating data up to the 2024–25 fishing year.

2.1 Data set

Commercial catch and effort data from the TRE 7 fishery were sourced from the Fisheries New Zealand EDW database. The data extract included the catch and effort data from any fishing trip that recorded a catch of trevally from TRE 7. The extract was supplemented by data from any additional fishing trips that conducted fishing within the statistical areas that comprise the TRE 7 QMA (Figure 1) (Statistical Areas 017 and 033–048) 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; dark ghost shark *Hydrolagus novaezealandiae*, GSH; giant stargazer

Kathetostoma giganteum, STA; and John dory *Zeus faber*, JDO) that are caught in association with trevally.

For the qualifying trips, all effort data records were sourced whether or not trevally 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 1993–94, many of the inshore trawlers operating in TRE 7 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 trevally 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 trevally landed catch records was screened to retain the records that represented the final destination of the trevally catch (destination codes L, LR, EOY, A, C, E, and O). Almost all (99.9%) 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. Trevally 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 trevally was apportioned amongst the daily fishing records in proportion to the estimated catches of trevally (when included within the five main species caught in the day). Trevally landed catches from trips without corresponding estimated catches were distributed amongst daily records in proportion to fishing effort (number of trawls).
2) **Trawl** (event) based catch and effort data set from 1993–94 to 2024–25. TCEPR, TCER, and ERS format catch and effort records. For each trip, the landed catch of trevally was apportioned amongst the individual trawl records in proportion to the estimated catches of trevally (when recorded in the five main species caught in the trawl). Trevally landed catches from trips without corresponding estimated catches were distributed equally amongst trawl records.

For the daily data set, almost all (>99.9%) of the landed catch of trevally was allocated to fishing days with associated estimated catches. Similarly, for the trawl event-based data set, 99.8% of the landed catch was allocated based on the estimated catches.

Total annual catches of trevally under the Quota Management System (QMS) are compiled from Monthly Harvest Returns (MHR) submitted by fishing permit holders. Since 2015–16, there was a considerable decline in the annual catch from the fishery with the lowest annual catch in 2023–24 (Figure 2).

Overall, the annual landed catches for TRE 7 included in the characterisation data set approximated the corresponding Fishstock catches reported by Fisheries New Zealand (Fisheries New Zealand 2025) (Figure 2).

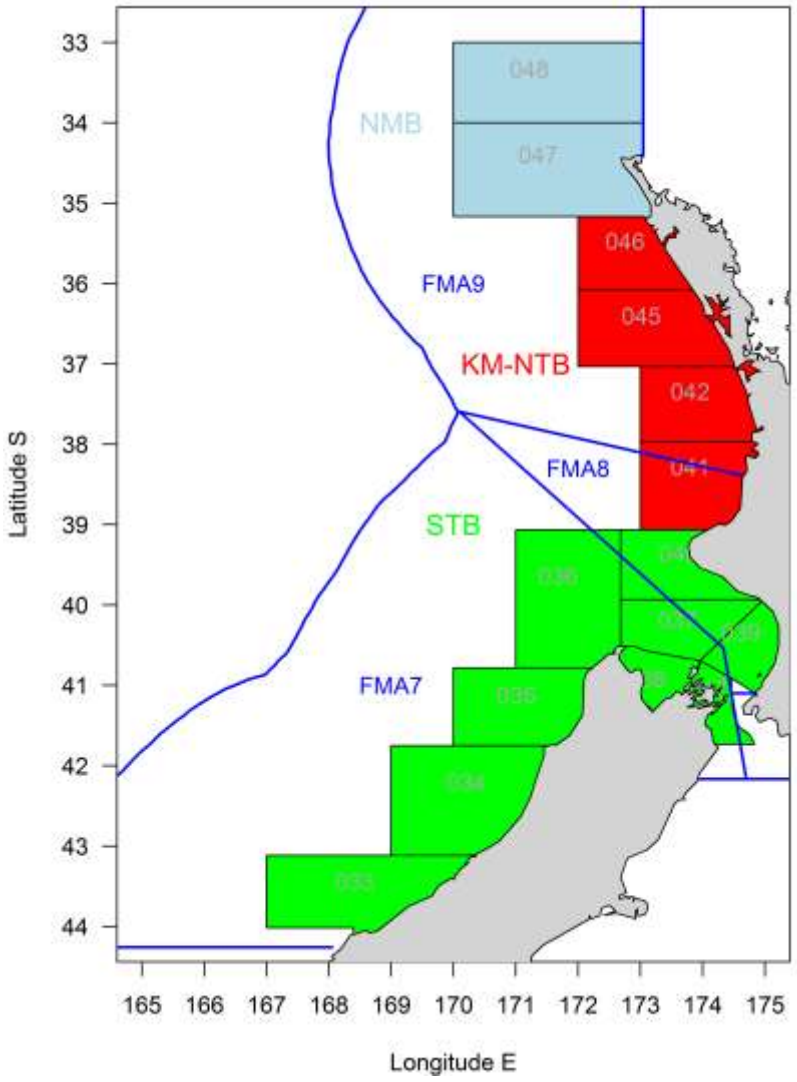


Figure 1: **Map of the TRE 7 Fishstock area and constituent Fishery Management Areas and Statistical Areas and the three sub-areas defined for the stock assessment (NMB, Ninety Mile Beach; KMNTB Kaipara, Manukau, North Taranaki Bight; STB, South Taranaki Bight).**

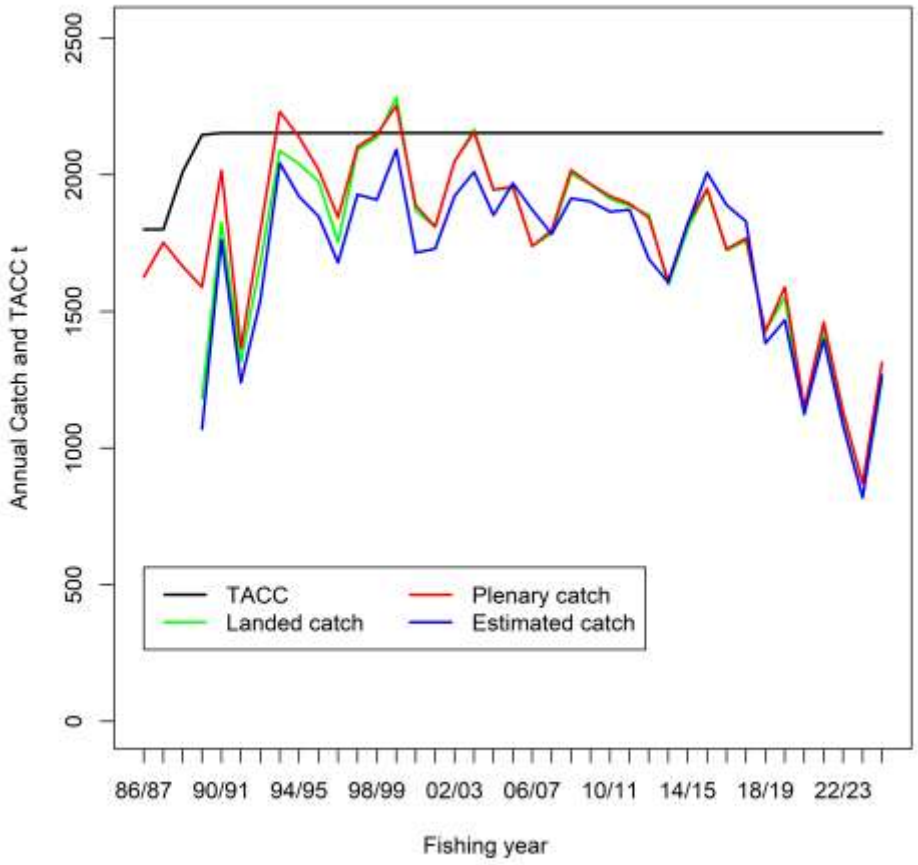


Figure 2: Annual TRE 7 reported catch (Plenary catch) and Total Allowable Commercial Catch (TACC) and the landed and estimated catch included in the catch and effort data set.

2.2 Recent trends

Since 1989–90, most of the TRE 7 catch has been taken off the northern west coast of the North Island (Figure 3 and Figure 4). Trevally were also caught in localised areas in the North Taranaki Bight, South Taranaki Bight and Kapiti Coast.

The decline in annual catch over the last decade predominantly occurred in the main area of the fishery north of Raglan Harbour (Statistical Areas 042, 045, 046 and 047) (Figure 4) with a reduction in the catch during the peak season (December-February) (Figure 5).

There was a corresponding decline in the catch from the target trevally single trawl fishery (Figure 6) and catches from this component of the fishery were minor in 2023–24 and 2024–25. This was partly compensated for by the increase in the trevally catch taken by the red gurnard trawl fishery and an increase in catch by Precision Harvesting trawl gear (PRB) targeting red gurnard, snapper and trevally (Figure 6).

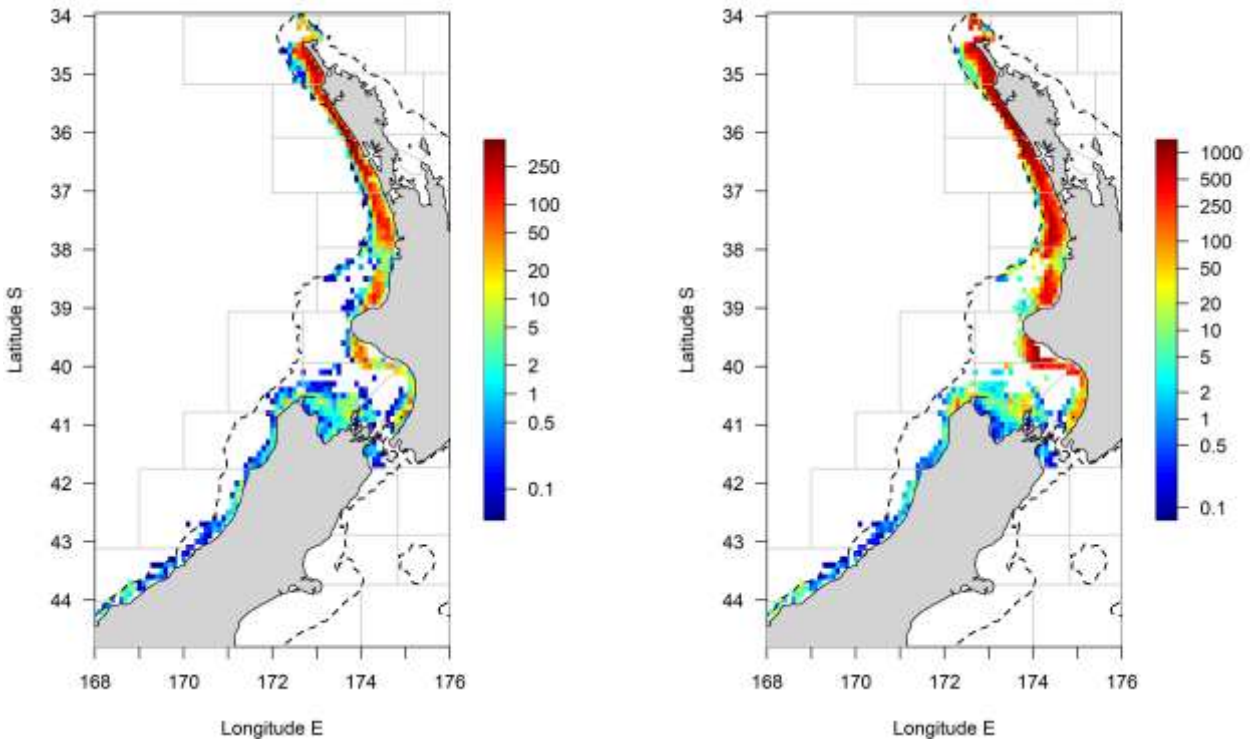


Figure 3: **Distribution of the total trevally catch (t) (left panel) and average trevally catch per trawl (kg) (right panel) from BT and PRB by 0.1 degree latitude and longitude (log scale) from 2007–08 to 2024–25. The black dashed line represents the 200 m depth contour. Each cell has data from a minimum of three permit holders.**

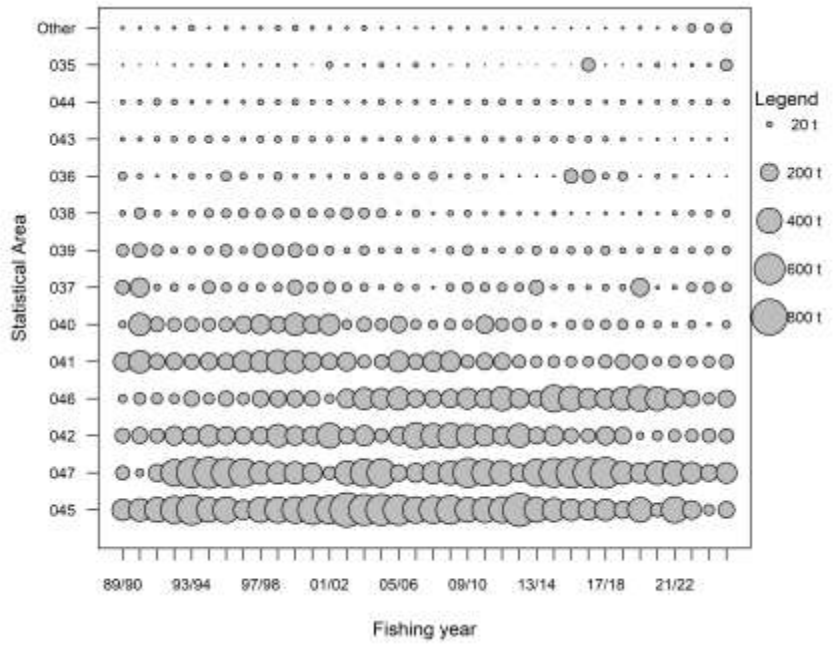


Figure 4: Annual trevally catch from the TRE 7 fishery by Statistical Area. The area of the circle is proportional to the catch.

A more detailed examination of the inshore trawl fishery was conducted using the event-based data available from 1993–94 onwards. The single trawl (BT or PRB) records were selected from Statistical Areas 039–047, excluding the harbour areas (043 and 044), and depths shallower than 150 m. The data set was limited to a core group of vessels participating in the fishery for more than 5 years with a minimum catch of 1000 kg per annum.

Most of the trevally catch was attributed to the target trawls (Figure 7). The number of target trawls was relatively low from 2022–23 to 2024–25, with a corresponding decline in trevally catch (Figure 7). Since 2010–11, there was a general increase in trawls targeting red gurnard and a limited number of trawls targeting snapper. Nonetheless, the catch rate of snapper increased during the same period and the catch of snapper increasingly dominated the catch of trevally (Figure 8).

The large reduction in trevally catch in 2023–24 and 2024–25 is attributable to the retirement of dominant vessels from the fleet. The vessel accounted for about 40–60% of the annual catch from 1999–2000 to 2022–23. There was also a large reduction in processing capacity with the closure of the Sanford Auckland facility in 2023.

From 2020–21, management changes were introduced to reduce mortality on Maui dolphins, including an extension of the exclusion zone for commercial trawling along the coast from North Taranaki Bight to Maunganui Bluff. Prior to 2020–21, a relatively small proportion of the trawl effort and trevally catch was within the exclusion area (Figure 9).

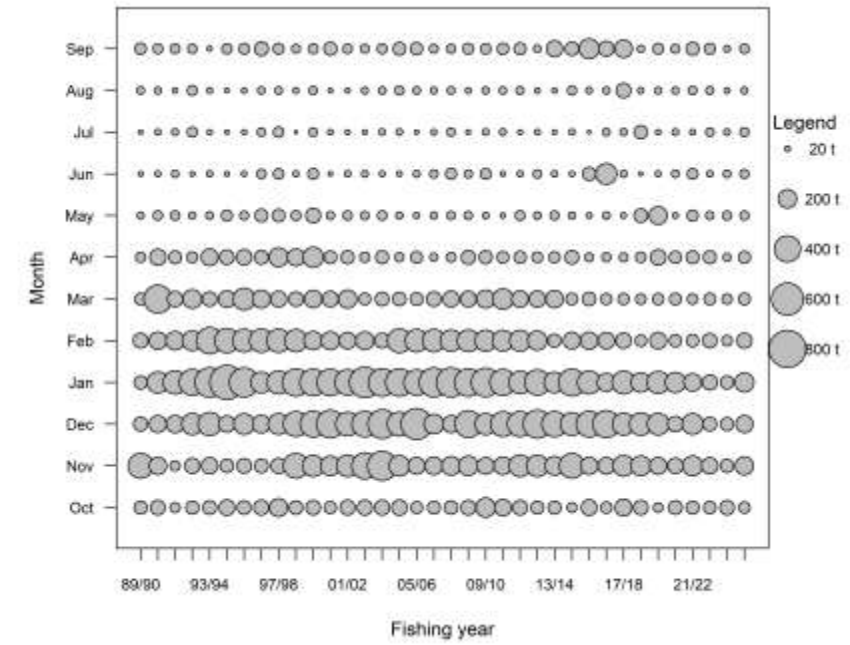


Figure 5: **Annual trevally catch from the TRE 7 fishery by month. The area of the circle is proportional to the catch.**

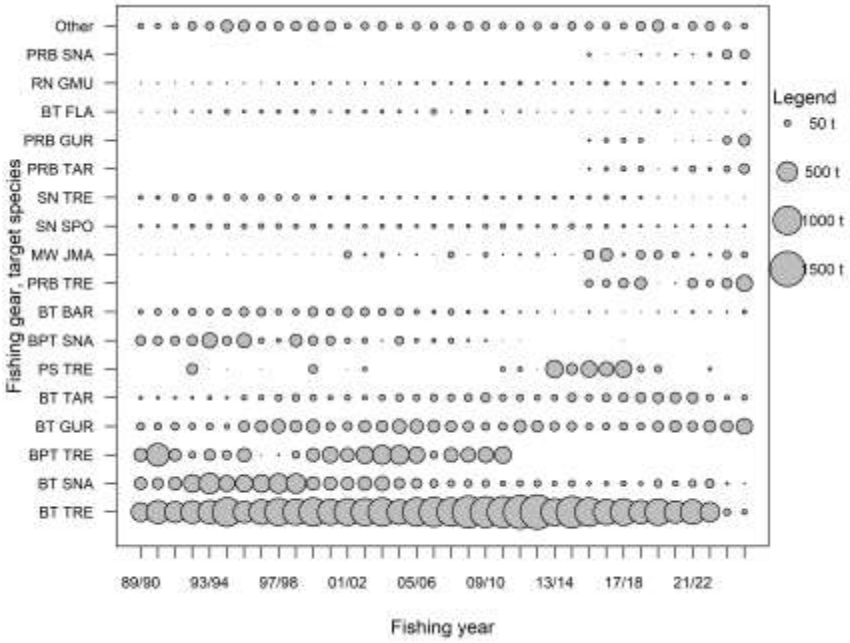


Figure 6: **Annual trevally catch from the TRE 7 fishery by fishing gear (BT, bottom single trawl; BPT, bottom pair trawl; BLL, bottom longline; PRB, Precision Harvesting bottom trawl gear; PS, purse seine; SN, set net; MW, mid-water trawl) and declared target species (SNA, snapper; TRE, trevally; GUR, red gurnard; TAR, tarakihi; JMA, jack mackerel; SPO, rig; FLA, flatfish; BAR, barracouta; GMU, grey mullet). The area of the circle is proportional to the catch.**

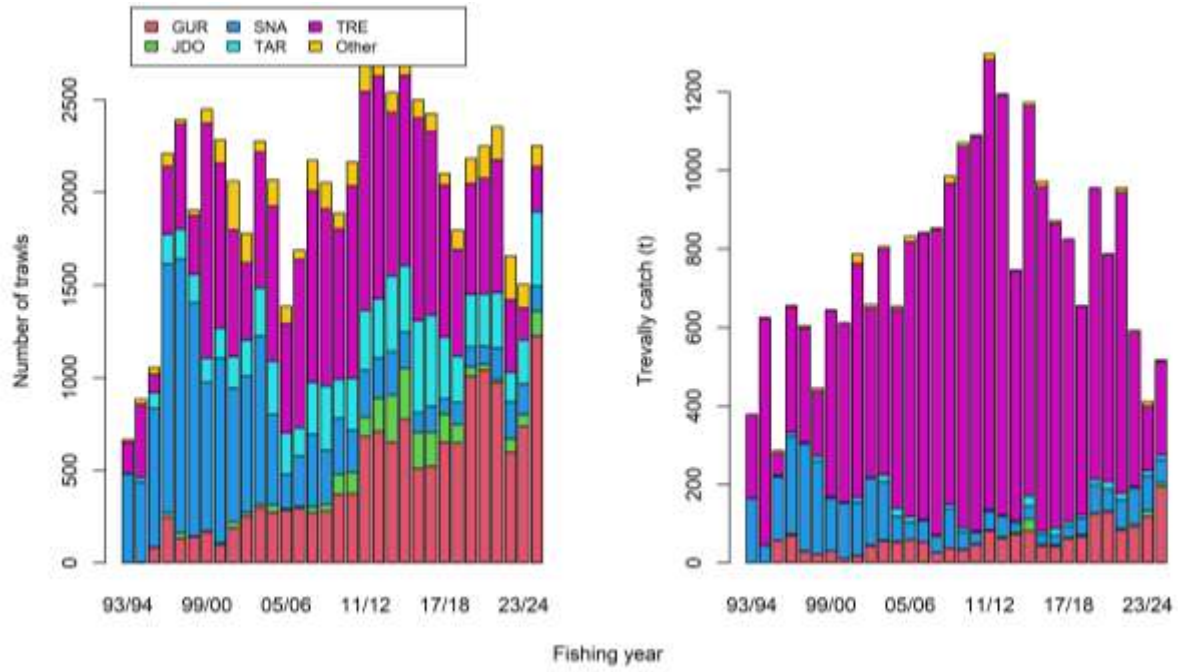


Figure 7: Annual number of trawls (left) and trevally catch (t) (right) by declared target species of the trawl from the event-based data set (for core vessels).

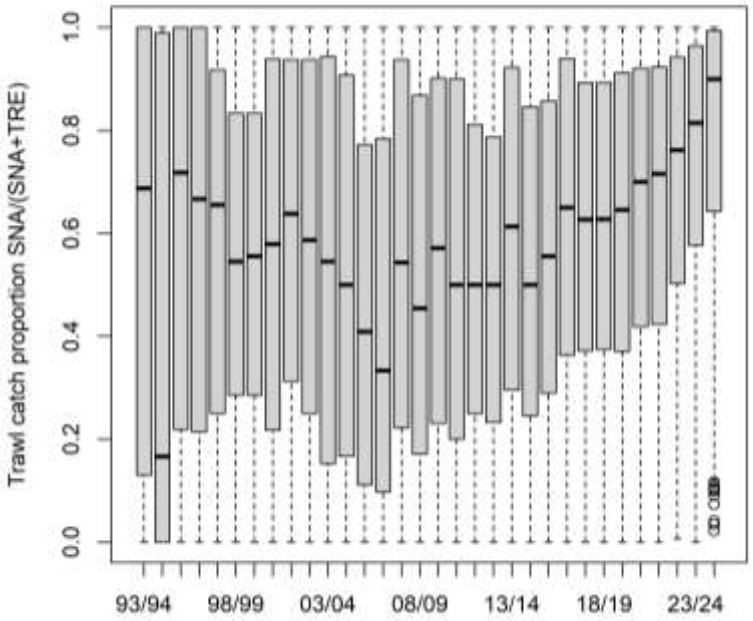


Figure 8: The annual proportions of snapper in the combined catches of snapper and trevally from the trawls included in the event-based data set (for core vessels).

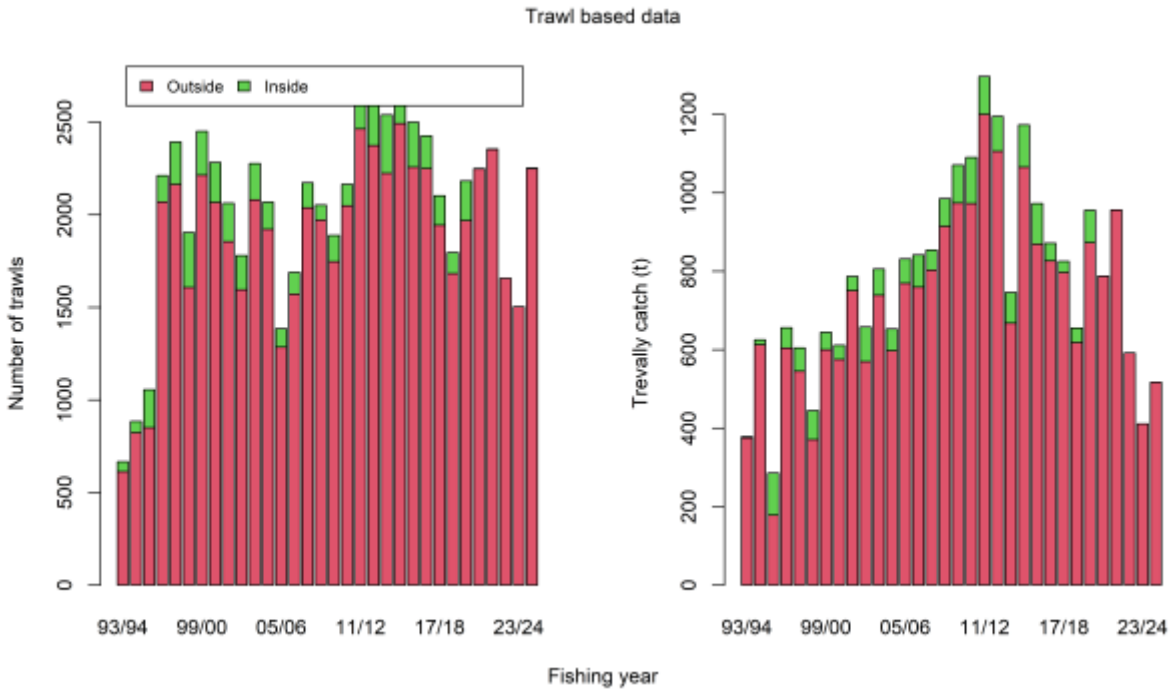


Figure 9: Annual number of trawls (left) and trevally catch (t) (right) inside and outside of the Maui dolphin trawl exclusion zone (as defined in 2020-21).

The core vessel event-based data set was applied to investigate changes in the spatio-temporal operation of the inshore west coast North Island trawl fishery. The analysis categorised individual trawls by month and 0.2 degree lat/long grid cell. A Generalised Linear Model was used to predict the trevally catch (natural logarithm) with the explanatory variables of vessel, fishing year, trawl duration and the interaction between month and grid cell. The resulting model was used to rank the month-grid cell coefficients from highest to lowest.

The highest month-grid cells were predominantly concentrated between Kaipara Harbour and Hokianga Harbour during December and January (Figure 10). Catch rates were lower throughout the domain of the fishery from March to October. The seasonal increase in catch rates occurred from November, initially in the north and then extended southwards during December and January. High catch rates also occurred south of Cape Egmont (an area known as “The Rolling Ground”) in April (Figure 10). Persistently low catch rates were identified in the southern area of the fishery (Figure 10).

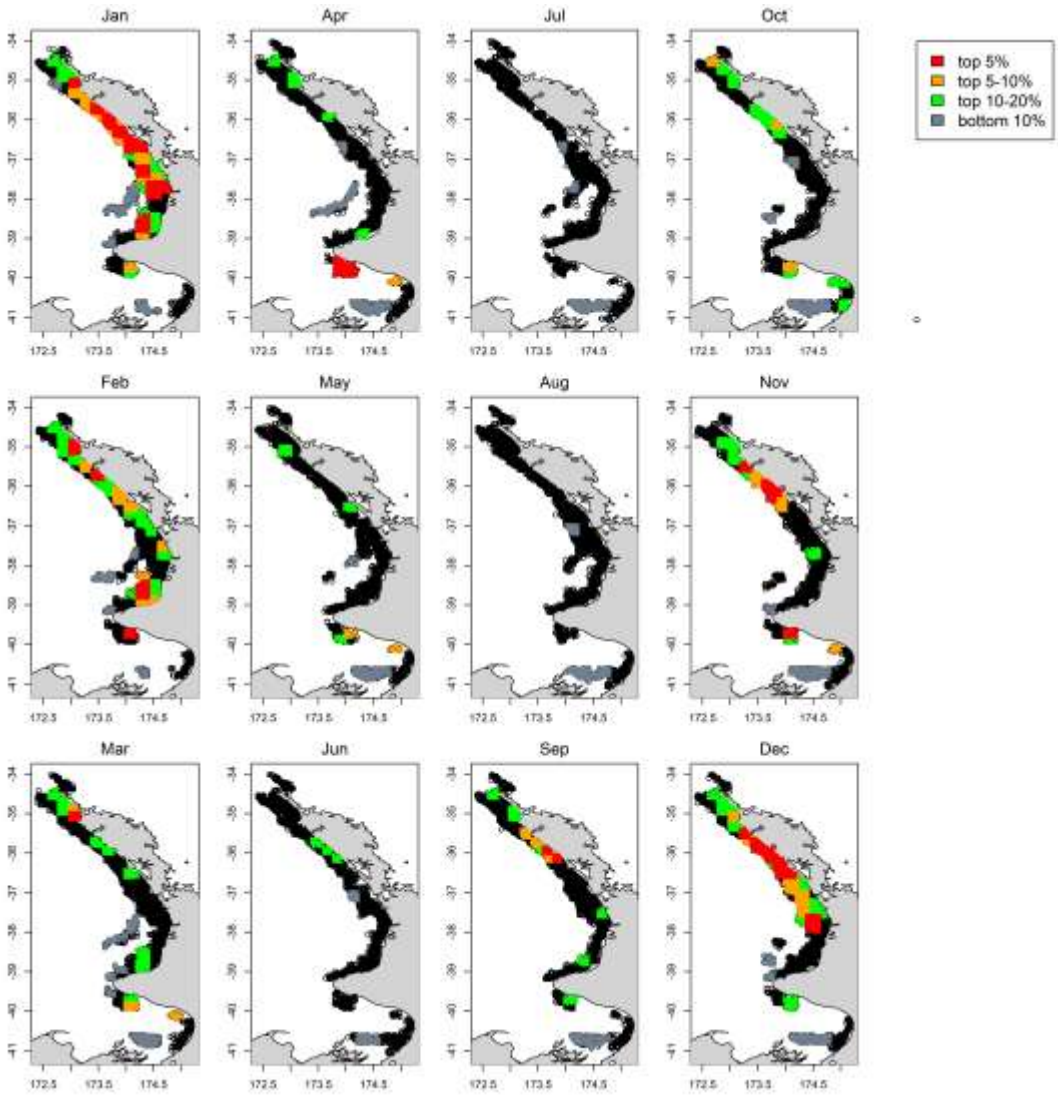


Figure 10: The ranking of individual month-grid coefficients from a Generalised Linear Model of trevally trawl catches.

For each year, the proportion of trawls in each month-grid cell was determined. Since 2006–07, there was a decline in the proportion of the trawls in the month-grid cells ranked within the top 10–20% (Figure 11) and a sharp drop in the proportion of trawls within the top 5% and 5–10% month-grid cells in 2023–24. This is primarily attributable to a decline in the trawl effort in the core area of the fishery during December and January.

Conversely, there was an overall increase in the proportion of trawl effort in the lowest ranked month-grid cells from 2007–08 (Figure 11).

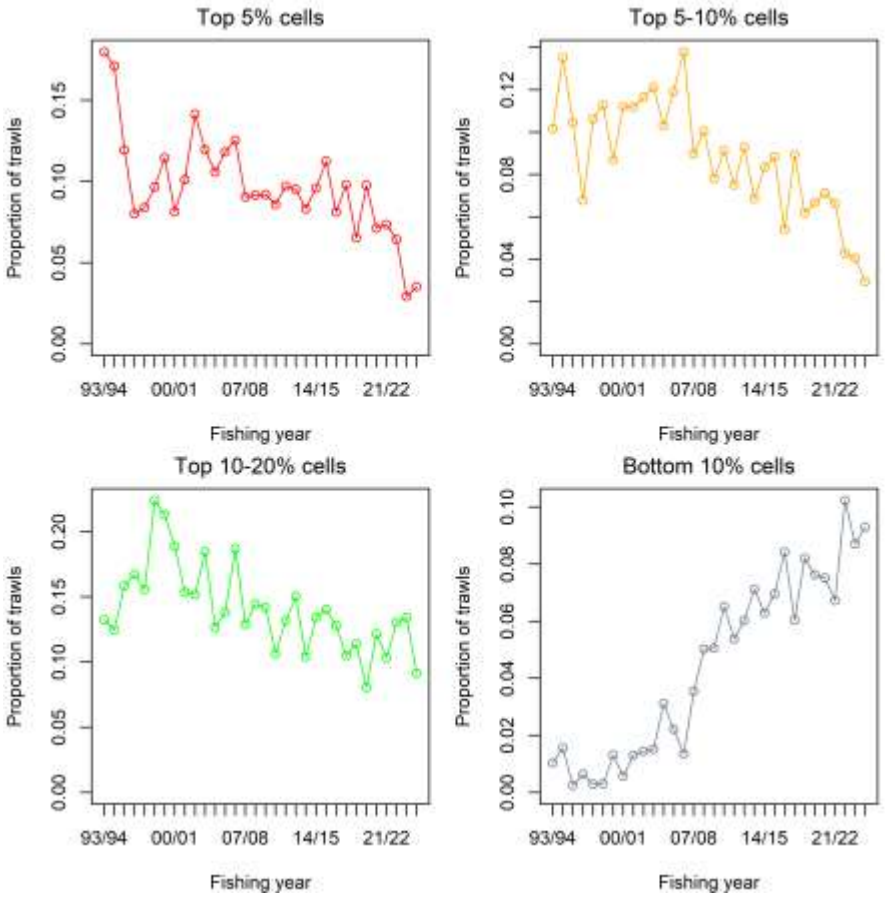


Figure 11: Proportion of trawls within each month-grid ranking category by fishing year.

3. CPUE ANALYSIS

The analysis updates and refines the previous CPUE indices from the TRE 7 trawl fishery (Langley et al. 2015). Previously, separate CPUE indices have been derived for three sub-areas of the TRE 7 fishery based on spatial differences in the CPUE trends and differences in the age composition of the commercial catches. The three sub-areas are: Ninety Mile Beach (NMB), Kaipara-Manukau to North Taranaki Bight (KMNTB) and South Taranaki Bight (STB) (Table 1). The trawl fishery definitions include both single trawl and Precision Seafood Harvesting trawl gear to account for increased dominance of the latter gear in the last few years.

Table 1: Summary of the CPUE data sets for the sub-areas of TRE 7.

Area	Statistical Areas	Method	Data format	Period
Ninety Mile Beach (NMB)	047	BT, PRB	Trawl	1993–94 to 2024–25
Kaipara-Manukau-North Taranaki Bight (KMNTB)	041, 042, 045, 046	BT, PRB	Trawl	1993–94 to 2024–25
South Taranaki Bight (STB)	037, 039, 040	BT, PRB	Day	1989–90 to 2024–25
			Trawl	2007–08 to 2024–25

Prior to 1993–94, almost all trevally catch and effort was reported in daily (CELR) format (Figure 12). For the two northern areas (NMB and KMNTB), event-based reporting was introduced through the mid-1990s and almost all data were reported in the event-based format from 2001–02 (Figure 12). The event-based data sets provide more detailed information than the daily data, specifically location and depth attributes for individual trawls. For the NMB and KMNTB CPUE analyses, it was considered that there were sufficient data available to include data from 1993–94 onwards in the CPUE data sets, although the data coverage is lower for the earlier years of the series (Table 1).

For the STB, most of the fishing events were reported in daily format prior to the introduction of TCER forms in 2007–08 (Figure 12). Two sets of CPUE analyses were conducted: a longer-term analysis based on all catch and effort compiled the daily format and a shorter series based on the event-based data (Table 1).

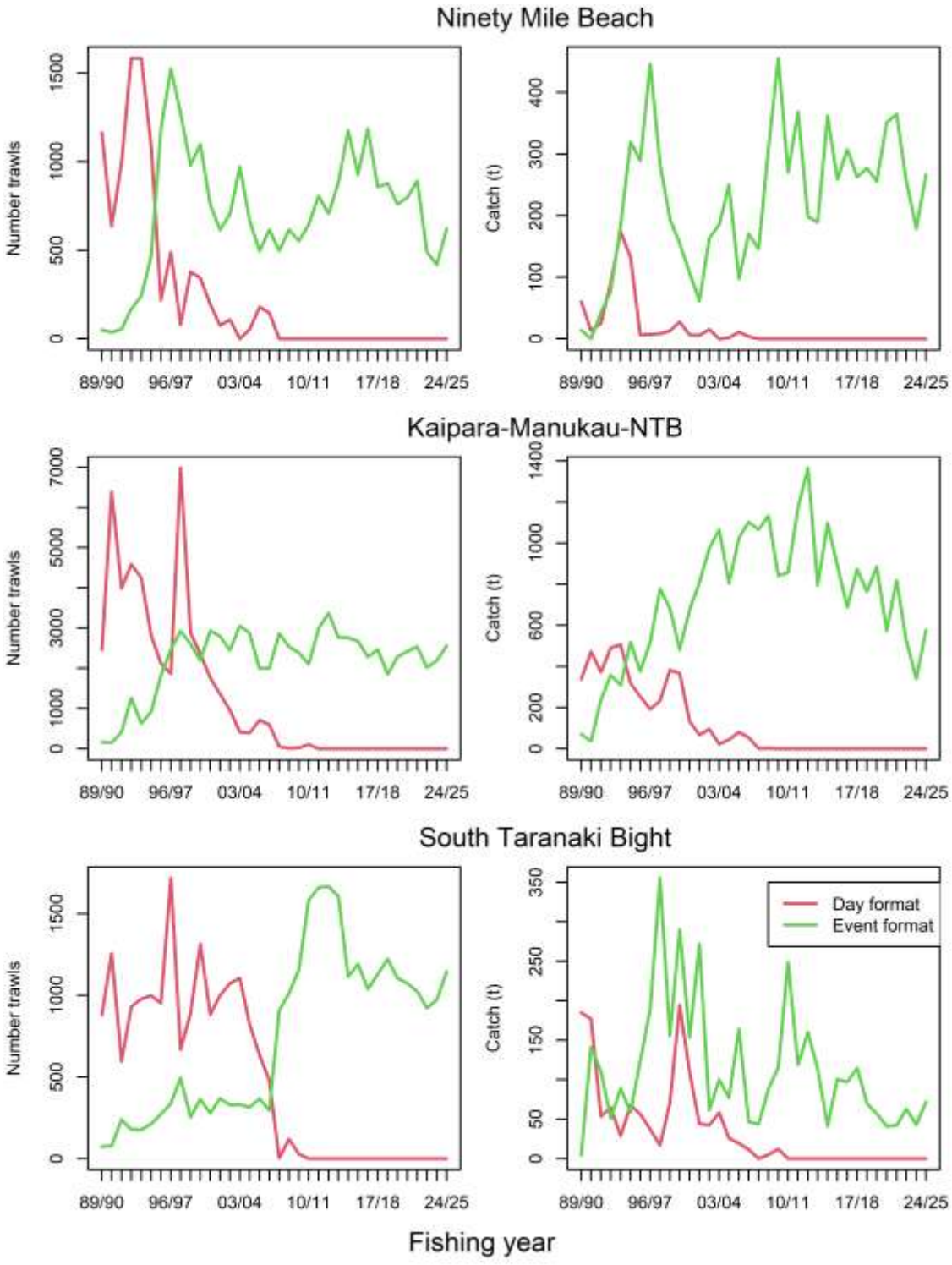


Figure 12: The annual number of trawls (left panels) and trevally catch (right panels) by data format and sub-area of TRE 7.

A Generalised Linear Modelling (GLM) approach was used to separately model the occurrence of trevally catches (presence/absence) and the magnitude of positive trevally 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 trevally catch was modelled based on a binomial distribution.

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 2) with the continuous variables typically parameterised as a third order polynomial function. The categorical variable *FishingYear* was included in the initial models 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.

Table 2: Variables included in the trawl event-based CPUE analyses.

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
GearAspect	Ratio of *GearWidth* to *GearHeight*	Continuous
TREcatch	Scaled estimated TRE trawl catch (kg)	Continuous
TREbin	Presence (1) or absence (0) of TRE catch in trawl	Categoric

3.1 Ninety Mile Beach

Initially, the NMB event-based data set included all trawl records from Statistical Area 047 in depths shallower than 150 m from 1993–94 to 2024–25. The data were restricted to a core set of vessels that participated in the fishery for at least 6 years with a minimum catch of 1000 kg per annum (Appendix 1 Table A1 and Figure A1).

The lognormal positive catch indices fluctuated over the period with lower catch rates during the late 1990s and early 2000s and during the late 2010s (Figure 13). Catch rates increased from 2018–19 to 2023–24. The trends in the lognormal indices were moderated by the inclusion of the trawl *Speed* variable in the CPUE model, accounting for faster trawling speeds from 2004–05 to 2023–24 associated with increased targeting of trevally (Appendix 1 Figure A4).

The binomial (occurrence) indices increased from the early 2000s (Figure 13) with the model accounting for an increase in fishing depth from 2009–10 onwards (Appendix 1 Figure A6). The binomial indices resulted in a general increasing trend in the final combined delta-lognormal indices (Figure 13).

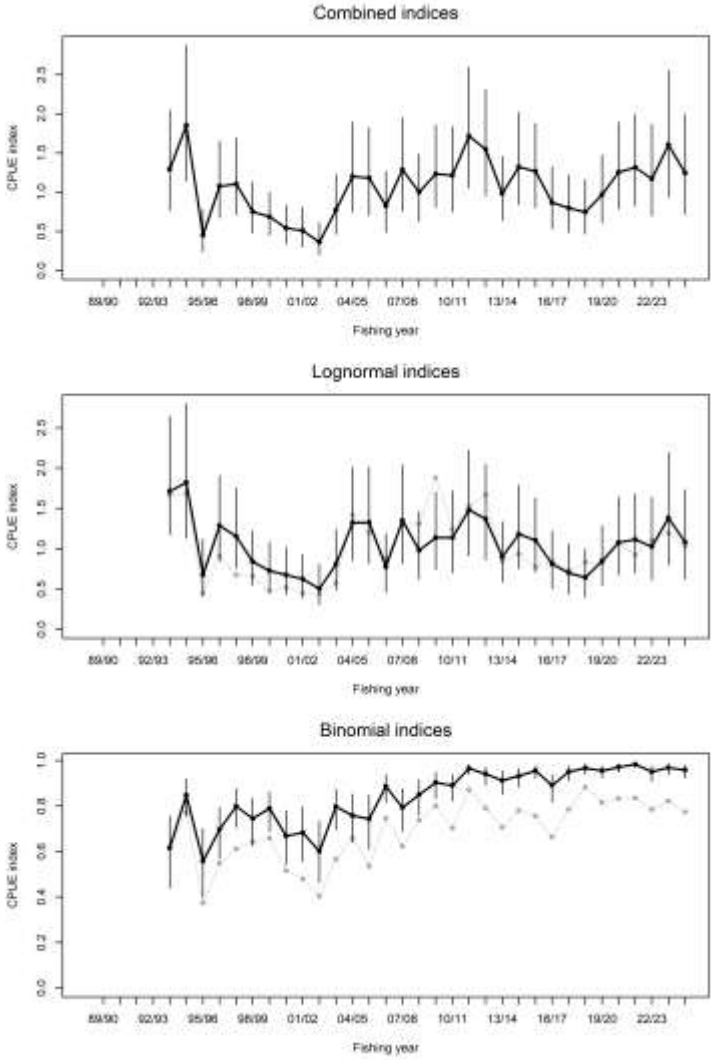


Figure 13: A comparison of: (middle panel) the NMB Trawl positive index and the geometric mean of the annual catch per trawl; (bottom panel) the binomial index and the annual proportion of positive catch records in the data set; and (top panel) the combined index. The error bars represent the 95% confidence intervals associated with each index. The annual indices are provided in Table A4 (Appendix 1).

3.2 Kaipara-Manukau and North Taranaki Bight

Initially, the KMNTB event-based data set included all trawl records from the constituent Statistical Areas (041, 042, 045 and 046) in depths shallower than 150 m. The data were then restricted to a core set of vessels that participated in the fishery for at least 6 years with a minimum catch of 1000 kg per annum (Appendix 2, Table A5 and Figure A9).

A range of CPUE models were investigated based on subsets of the core vessel dataset, specifically partitioning the data by seasons (October-April, May-September), excluding a single dominant vessel and restricting the analysis to the area outside of the current trawl exclusion zone.

The final CPUE data set was limited to the main fishing period (October-April); an examination of the catch sampling data indicated that a higher proportion of larger/older fish were taken during the period, aligning with the assumption of full selectivity in the assessment model. The CPUE data set also excluded trawl records from within the area that was closed to trawling in 2020–21.

The main explanatory variables included in the lognormal model were trawl *Speed* and *Vessel* (Appendix 2, Table A6). The inclusion of the *Speed* variable increased the lognormal indices in the recent period, accounting for an overall decline in trawl speed since 2020–21 (Appendix 2, Figure A11). The binomial model indices increased from 2010–11, accounting for an increase in the proportion of deeper (100–150 m) trawls during the period (Appendix 2, Figure A13).

Overall, the combined KMNTB CPUE indices fluctuated over the entire period and recent indices (from 2021–22 to 2024–25) were at or above the average of the series (Figure 14).

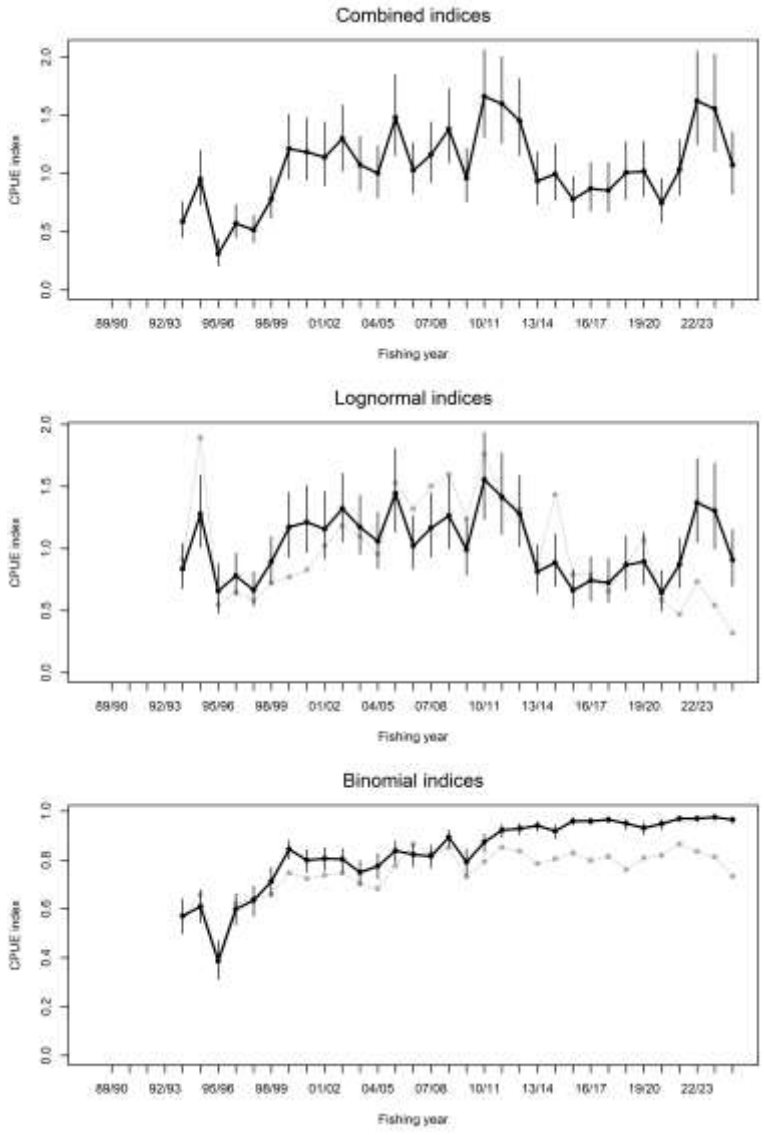


Figure 14: A comparison of: (middle panel) the KMNTB Trawl positive index and the geometric mean of the annual catch per trawl; (bottom panel) the binomial index and the annual proportion of positive catch records in the data set; and (top panel) the combined index. The error bars represent the 95% confidence intervals associated with each index. The annual indices are provided in Table A8 (Appendix 2).

3.3 South Taranaki Bight

A comprehensive set of trawl event-based data are available from the South Taranaki Bight fishery from 2007–08 onwards (Figure 12). The initial data set included trawl records from Statistical Areas 037, 039 and 040 in depths less than 150 m. The data set was further restricted to a core group of vessels that participated in the fishery for at least 6 years with a minimum catch of 1000 kg per annum (Appendix 3, Table A9 and Figure A16).

The CPUE indices increase considerably from 2020–21 to 2022–23 with both the binomial and lognormal models compensating for changes in the operation of the fishery (Figure 15). The binomial model accounted for a shift to deeper trawls from 2017–18 (Appendix 3 Figures A22), whereas the lognormal model accounted for a reduction in trawl speed and lower trawl headline height in recent years (Appendix 3 Figures A19 and A21).

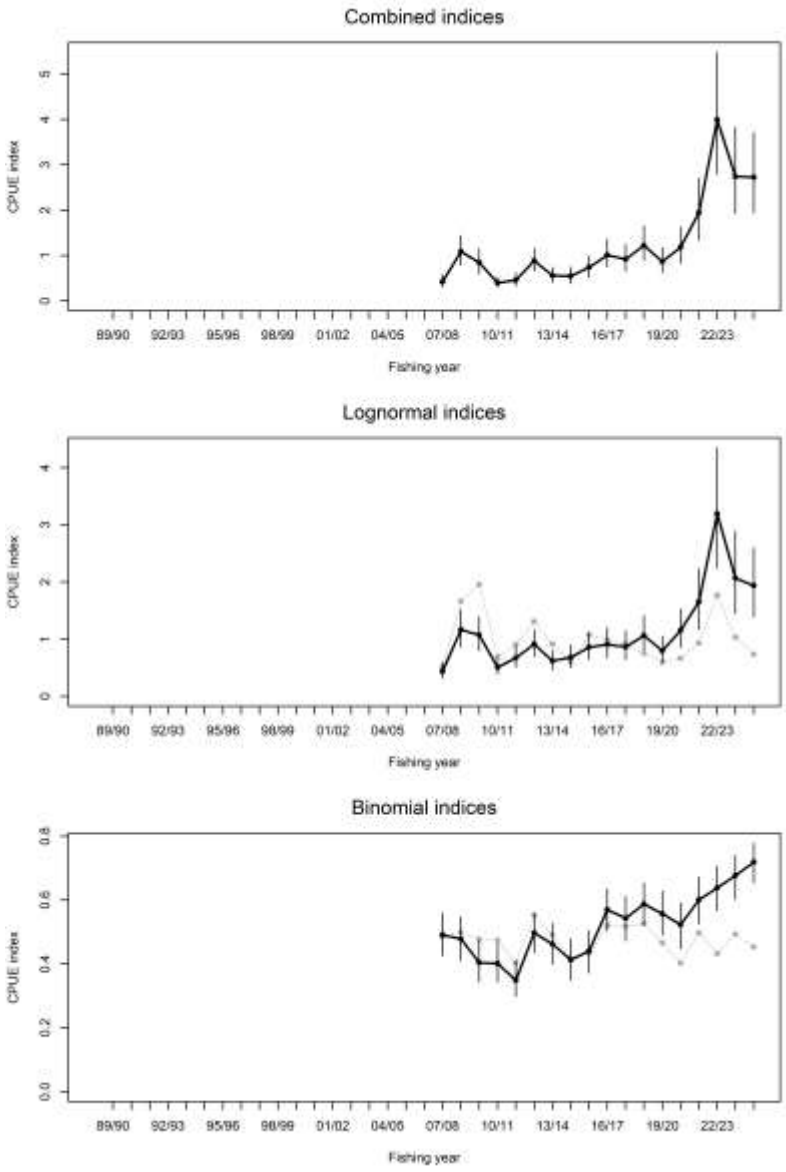


Figure 15: A comparison of: (middle panel) the STB Trawl positive index and the geometric mean of the annual catch per trawl; (bottom panel) the binomial index and the annual proportion of positive catch records in the data set; and (top panel) the combined index. The error bars represent the 95% confidence intervals associated with each index. The annual indices are provided in Table A12 (Appendix 3).

A longer-term series of CPUE indices was derived for the STB fishery from the daily aggregated data. The daily indices were comparable to the event-based indices from 2007–08 to 2021–22, while the daily indices remained at a lower level in the more recent years (Figure 16). The precision of the daily indices

is relatively low for the latter period (2022–23 to 2024–25). For the earlier years (1989–90 to 2006–07), the daily indices vary considerably and precision is relatively low (Figure 16).

In general, the higher resolution event-based CPUE indices are likely to be more reliable than the daily CPUE indices as the CPUE models can account for changes in the operation of the fishery that may be obscured by the aggregation of catch and effort data by fishing day. Nonetheless, the shorter time-series of the event-based data and changes in the operation of the fishery may limit the explanatory power of the CPUE models, introducing a degree of uncertainty in the magnitude of the increase in the recent indices.

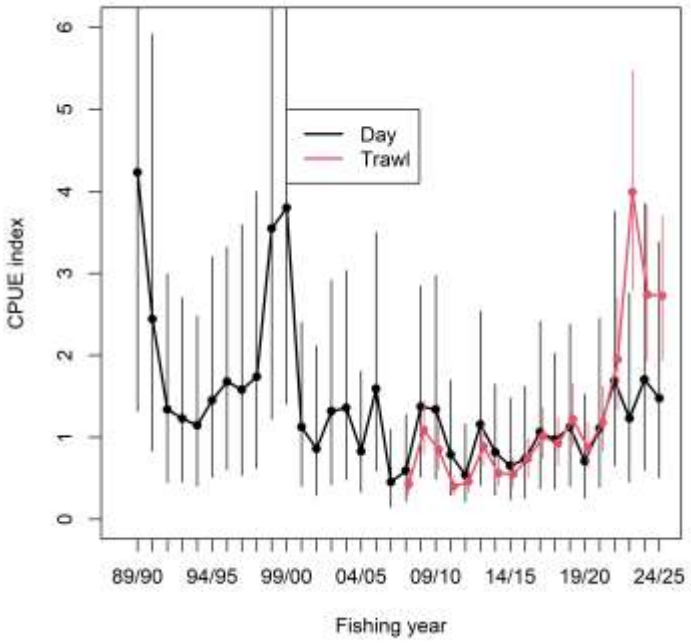


Figure 16: A comparison of the South Taranaki Bight (STB) event-based (trawl) and daily CPUE indices.

3.4 Comparisons between areas

There is a general correspondence between the CPUE indices from the NMB and KMNTB trawl fisheries from 2004–05 onwards, although the trends in the indices differ considerably in the earlier years (Figure 17).

The trends in the event-based indices for the STB fishery differ considerably from the other two northern areas, in particular the large increase in the recent STB indices is not evident for the other areas (Figure 17).

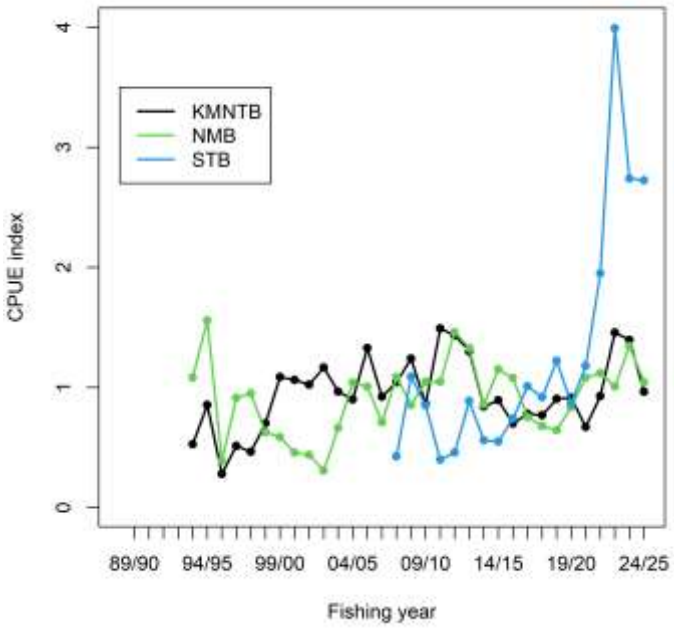


Figure 17: A comparison of the trawl event-based CPUE indices from the three sub-areas.

4. DATA COMPILATION

4.1 Commercial catch history

Francis & Paul (2013) tabulated annual reported commercial catches (domestic and foreign) of trevally by Fishery Management Area (FMA) for 1931–1982. For this period, annual catches for TRE 7 were determined from the combined catches from FMAs 7, 8 and 9. Annual reported TRE 7 commercial catches from the more recent years (1983–2025) were sourced from Fisheries New Zealand (2025) (Figure 18). Annual catches by fishing year were assigned to the calendar year of the January–September period (e.g. catches from 2024–25 were assigned to the 2025 year in the assessment model).

Previous TRE 7 stock assessments have included an allowance for the discard of trevally catches prior to 1970 (Fisheries New Zealand 2025). The discarded catch component was specified as a percentage of the annual reported commercial catch; 50% during 1944–59, 20% during 1960–65 and 5% during 1966–69. Similarly, previous assessments have included an allowance for unreported commercial catch expressed as a percentage of the annual reported commercial catch; 20% during 1944–1986, 10% in 1987 and then decreasing by 1% per annum to prior to 1997 and remaining at 1% during 1997–2025 (Figure 19). The total TRE 7 commercial catch was determined from the addition of the reported catch and the allowances for discards and unreported catch.

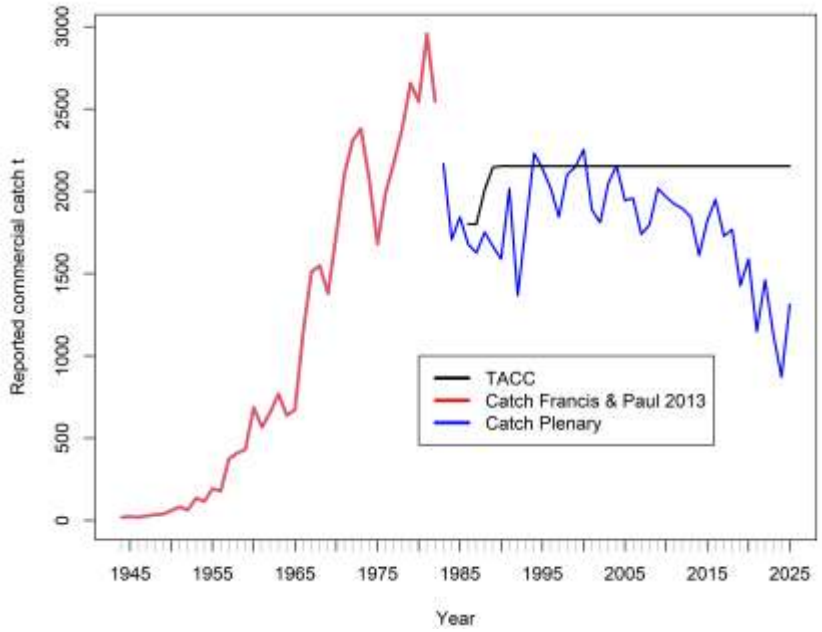


Figure 18: Annual reported commercial catch from the TRE 7 fishery and the TACC.

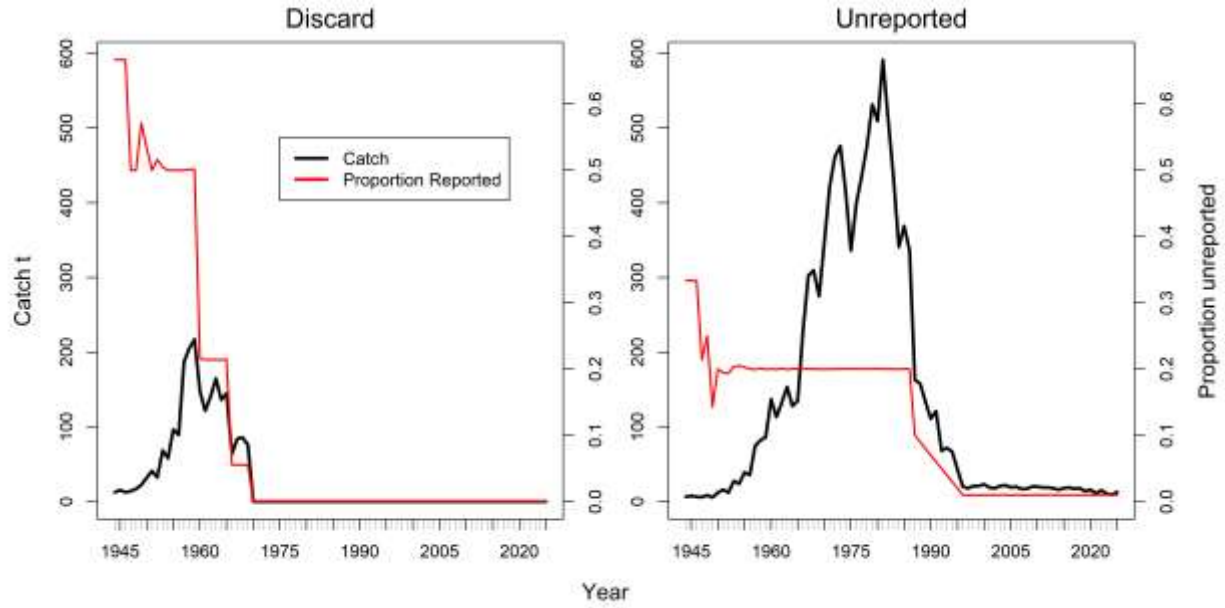


Figure 19: Annual discarded and unreported trevally catches assumed for the stock assessment.

Initially, the catch data were configured to include six commercial fisheries with a single trawl and a pair trawl fishery in each of the three sub-areas. The current catch and effort reporting regime provides sufficient information to determine the proportion of the total catch from each area/method fishery from 1990–2025. For the preceding period, limited catch and effort data are available and it was necessary to

apportion the annual total TRE 7 commercial catch among fishing methods and sub-areas based on the following assumptions.

For 1944–82, the total annual catch was apportioned among sub-areas based on the FMA catches from Francis & Paul (2013). The combined FMA 7 and 8 areas approximate the STB subarea, although there is some overlap of FMA 8 and the KM-NTB sub-area (Figure 1). On that basis, the entire catch from FMA 7 and 80% of the catch from FMA 8 was allocated to the STB sub-area.

For 1944–82, the combined KM-NTB and NMB catch was determined from the entire FMA 9 catch and the remaining 20% of the catch taken from FMA 8. The combined catch was then apportioned between the two subareas based on the average annual proportion of the catch taken from the two areas (77% KM-NTB, 23% NMB) in 1990–2013.

For 1983–89, total annual catches were allocated amongst the three sub-areas based on the average of the annual proportion of the total catch from the period immediately preceding 1983 (1978–82) and immediately following 1989 (1990–95) (i.e. NMB 22%, KM-NTB 57% and STB 21%).
Pair trawling commenced in the TRE 7 fishery in about 1974. For the preceding period, the total sub-area commercial catch was assigned to the single trawl fishery.

Francis et al. (1999) provides a summary of the monthly catches of trevally by vessel type (single trawlers, small pair trawlers and large pair trawlers) based on the catch landed at Onehunga (predominantly TRE 7 catches). This catch was assumed to be representative of the combined KM-NTB and NMB catch. The annual proportion of the catch taken by the single trawl and pair trawl methods was used to apportion the sub area commercial catches amongst the two fishing methods from 1974 to 1986. Gear specific catch data were not available for the STB area and catches were therefore split equally between the two fishing methods from 1974 to 1986. For all three areas, the sub-area catches from 1987–89 were allocated between fishing methods based on the average annual proportional split of the catch from the specific sub-area during 1990–93.

For the final assessment models, the catch data sets were configured to include four commercial fisheries: a single trawl fishery in the KMNTB and NMB subareas, a BPT fishery for KMNTB and NMB subareas combined, and a SBT fishery (BT and BPT combined) (Appendix 4 Table A14). The base assessment model is initialised in 1975 and includes the KMNTB and NMB sub-areas only. The model excludes catches prior to 1975 and does not include the catch from STB sub-area (Figure 20).

The final assessment models also included a non-commercial fishery that encompassed catches from the customary and recreational sectors. Recreational catch estimates are available from National Panel Surveys in 2012, 2018 and 2023 (Fisheries New Zealand 2025). The three estimates of recreational catch are very low (29 t, 64 t and 36 t, respectively) relative to the commercial catches. The non-commercial component of the catch was assumed to be taken entirely within the KM-NTB sub-area.

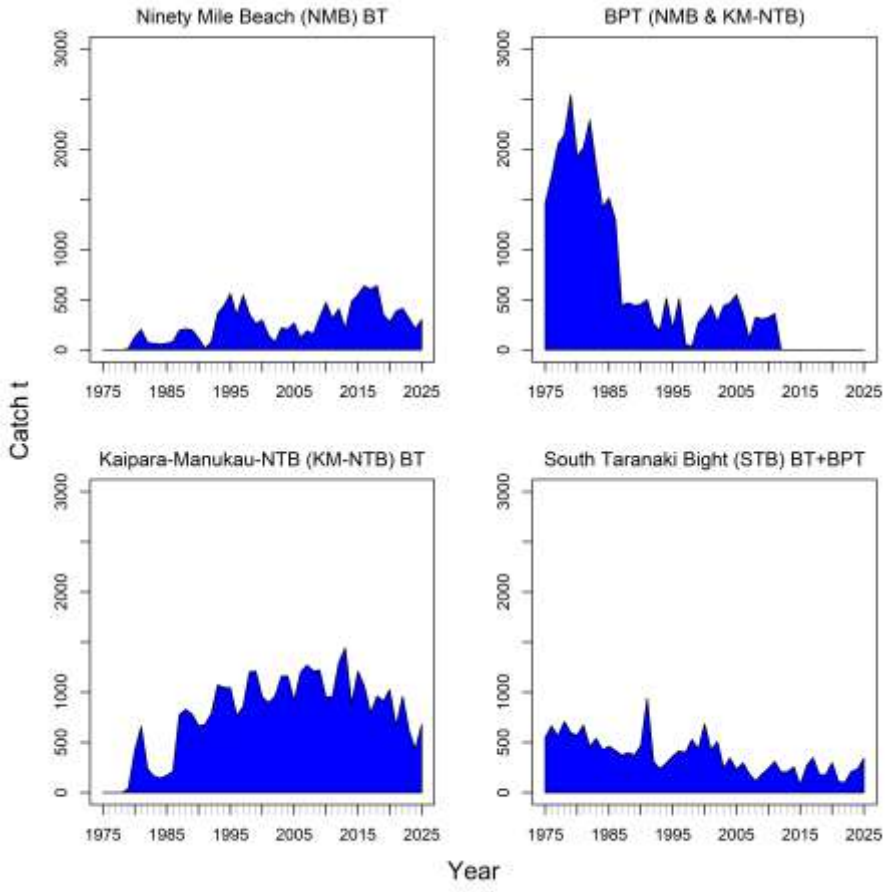


Figure 20: Annual total commercial TRE 7 catches from 1975 onwards apportioned among fishery areas and fishing methods, includes allowances for discards and under reporting of catch. The assessment models are initialised in 1975.

4.2 Age Compositions

Previous studies have concluded that there is no sexual dimorphism in the growth of trevally in TRE 7. There is also no indication of sex-specific differences in fishery selectivity. On that basis, the fishery age composition data have been routinely configured as a composite age composition (both sexes combined).

Age compositions are available from the single trawl fisheries in each of the three sub-areas: NMB, KMNTB and STB (Table 3). Since the last stock assessment, additional age composition data were collected from the fishery sub-areas in 2022–23 and 2023–24 (Armiger et al. 2025).

The derivation of the early (1974–79) BPT age compositions are documented in McKenzie (2008, see appendix A2.2). No information is available that details the location of the catch from the individual sampled landings. However, most of the total TRE 7 catch from 1974–79 was taken from the KM-NTB area and, on that basis, the 1974–79 BPT age compositions were assigned to that sub-area (Table 3).
For the more recent years, the catch statistics indicate that most of the TRE 7 BPT catch was taken from the KM-NTB sub-area.

The previous stock assessment highlighted differences in age composition of trevally sampled between vessels, with the dominant vessel catching older fish in 2009–10 and 2012–13 (Langley et al. 2015). This vessel accounted for most of the catch sampled from the northern areas of TRE 7 in 2022–23 but did not participate in the fishery in 2023–24. Therefore, it was not possible to make direct comparisons of the age composition of the sampled catches between vessels in those years. However, there was no indication of a large difference in the combined age compositions between 2022–23 and 2023–24 that could be attributed to the retirement of the dominant vessel from the fishery (Figure 21). For the current assessment, the trawl fishery reverted to a single fleet (all vessels combined) and any variation between vessels was considered to represent sampling error in the time-series of the age composition data.

Comparative age compositions are available from the single trawl fishery in the three sub-areas for six years (Table 3 and Figure 21). Prior to 2022–23, the relative strength of individual year classes are similar between the three sub-areas, although the proportion of older fish in the sampled catch tended to increase southward from NMB to KMNTB to STB (Figure 21). The most recent age compositions from the STB sub-area are characterised by an exceptionally strong 2018 year class, sampled at age 5 and 6 years in 2022–23 and 2023–24, respectively. This year class was not evident as a particularly strong year class in the other two northern sub-areas (Figure 21).

Table 3: A summary of individual TRE 7 age samples included in the stock assessment models.

Sub area	Fishery /survey	Fishing year	Model Year	Max age	MW CV %	Source
KM-NTB	BT	1997–98	1998	30	41.5	Walsh & McKenzie 2009
KM-NTB	BT	1998–99	1999	20	18	Walsh & McKenzie 2009
KM-NTB	BT	1999–00	2000	30	31.1	Walsh & McKenzie 2009
KM-NTB	BT	2000–01	2001	30	29.0	Walsh & McKenzie 2009
KM-NTB	BT	2005–06	2006	30	34.7	Langley 2009
KM-NTB	BT	2006–07	2007	30	24.1	Walsh et al. 2012
KM-NTB	BT	2007–08	2008	30	23.9	Walsh et al. 2012
KM-NTB	BT	2009–10	2010	30	39.9	Walsh et al. 2012
KM-NTB	BT	2012–13	2013	30	37.9	Walsh et al. 2014
KM-NTB	BT	2022–23	2023	20	28.8	Armiger et al. 2025
KM-NTB	BT	2023–24	2024	20	34.8	Armiger et al. 2025
KM-NTB	BPT		1974	13	Na	McKenzie 2008
KM-NTB	BPT		1975	13	Na	McKenzie 2008
KM-NTB	BPT		1976	13	Na	McKenzie 2008
KM-NTB	BPT		1978	40	Na	McKenzie 2008
KM-NTB	BPT		1979	40	Na	McKenzie 2008
KM-NTB	BPT	1997–98	1998	20	23	Walsh & McKenzie 2009
KM-NTB	BPT	1998–99	1999	20	18	Walsh & McKenzie 2009
KM-NTB	BPT	2000–01	2001	20	Na	Langley 2002
NMB	BT	1997–98	1998	30	67.2	Walsh & McKenzie 2009
NMB	BT	1998–99	1999	20	42.9	Walsh & McKenzie 2009
NMB	BT	1999–00	2000	30	38.3	Walsh & McKenzie 2009
NMB	BT	2000–01	2001	20	Na	Langley 2002
NMB	BT	2006–07	2007	30	43.0	Walsh et al. 2012
NMB	BT	2007–08	2008	30	31.6	Walsh et al. 2012
NMB	BT	2009–10	2010	30	25.0	Walsh et al. 2012
NMB	BT	2012–13	2013	30	30.2	Walsh et al. 2014
NMB	BT	2022–23	2023	20	33.7	Armiger et al. 2025
NMB	BT	2023–24	2024	20	26.2	Armiger et al. 2025
STB	BT	2006–07	2007	30	39.3	Walsh et al. 2012
STB	BT	2007–08	2008	30	38.6	Walsh et al. 2012
STB	BT	2009–10	2010	30	45.2	Walsh et al. 2012
STB	BT	2012–13	2013	30	40.0	Walsh et al. 2014
STB	BT	2022–23	2023	20	42.1	Armiger et al. 2025
STB	BT	2023–24	2024	20	38.0	Armiger et al. 2025

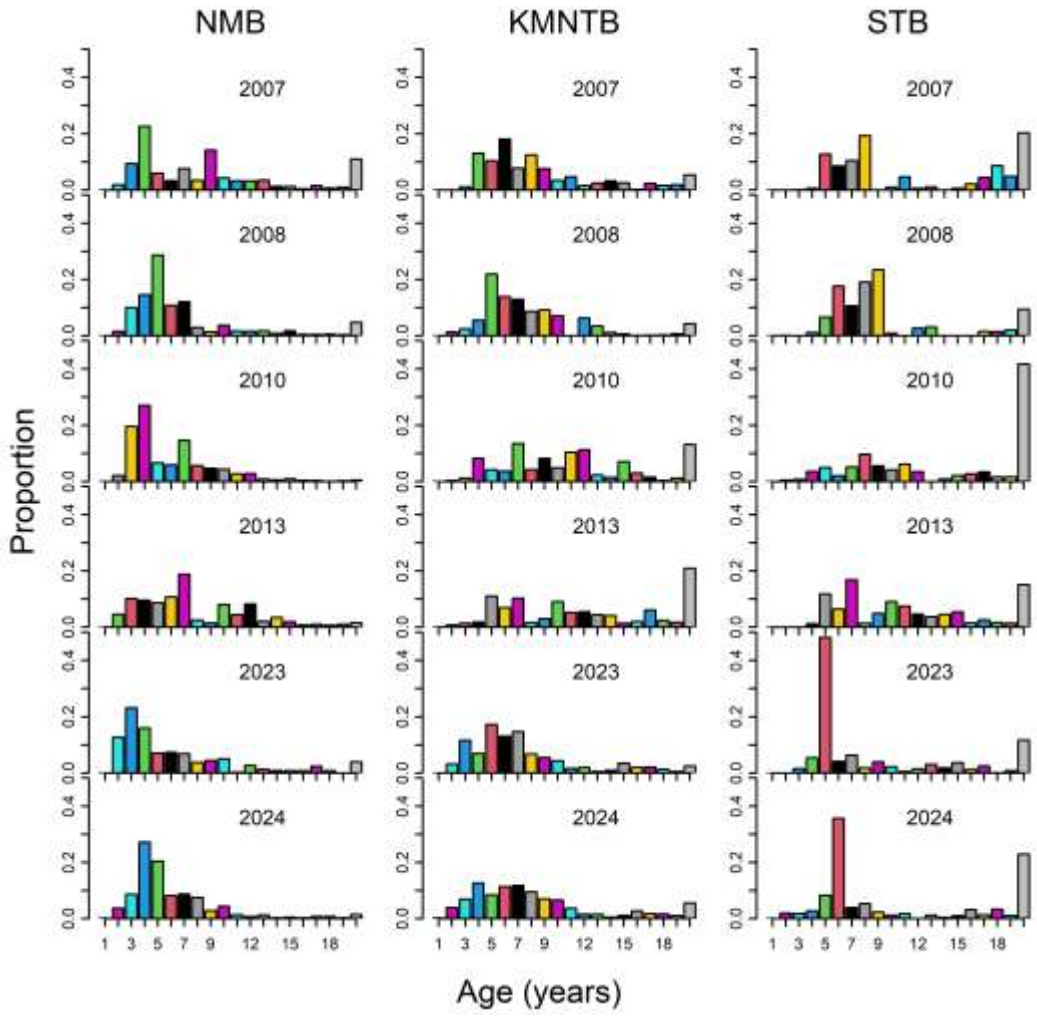


Figure 21: A comparison of age compositions from the NMB, KMNTB and STB single trawl fisheries. The colour denotes the individual year classes. The oldest age class represents fish aged 20 years and older.

4.3 Age and growth

Previous TRE 7 assessments had used established growth parameters from James (1984). A comparison between the growth model and length-at-age observations from the recent sampling programme revealed that growth was over-estimated for the northern area of TRE 7 (North Taranaki Bight, Kaipara-Manukau and Ninety Mile Beach), whereas the growth model was consistent with the observations from South Taranaki Bight. The difference in the growth model for northern trevally was also evident from the length-age observations of fish sampled from the fishery in the 1970s.

For the northern areas, growth parameters were re-estimated using the data from the 2022–23 and 2023–04 aged otolith sample. Data were limited to the main fishing season (October-April), representing a total of 2466 otoliths. A Von Bertalanffy growth model was fitted for both sexes combined, with individual observations weighted inversely proportional to the number of observations in each age class. As the data were obtained from a commercial fishery with a Minimum Legal Size (MLS), there is a positive bias in

the length-at-age of the younger fish. Thus, the model was constrained to fit the modal length of 1 year (12 cm) fish observed in the WCNI *Kaharoa* trawl surveys.

The length based selection of the commercial fishery is evident from the positive model residuals for the younger (2–5 year) age classes (Figure 22). For older (9–18 year) age classes, the model over-estimates growth by an average of 2–3 cm (Figure 22). An alternative model structure, using the Schnute parameterisation, improved the fit to the observed data but yielded unrealistic growth rates for younger fish. In order to improve the determination of TRE 7 trevally growth rates additional otoliths would need to be collected from younger fish caught in trawl surveys or other fishery independent methods.

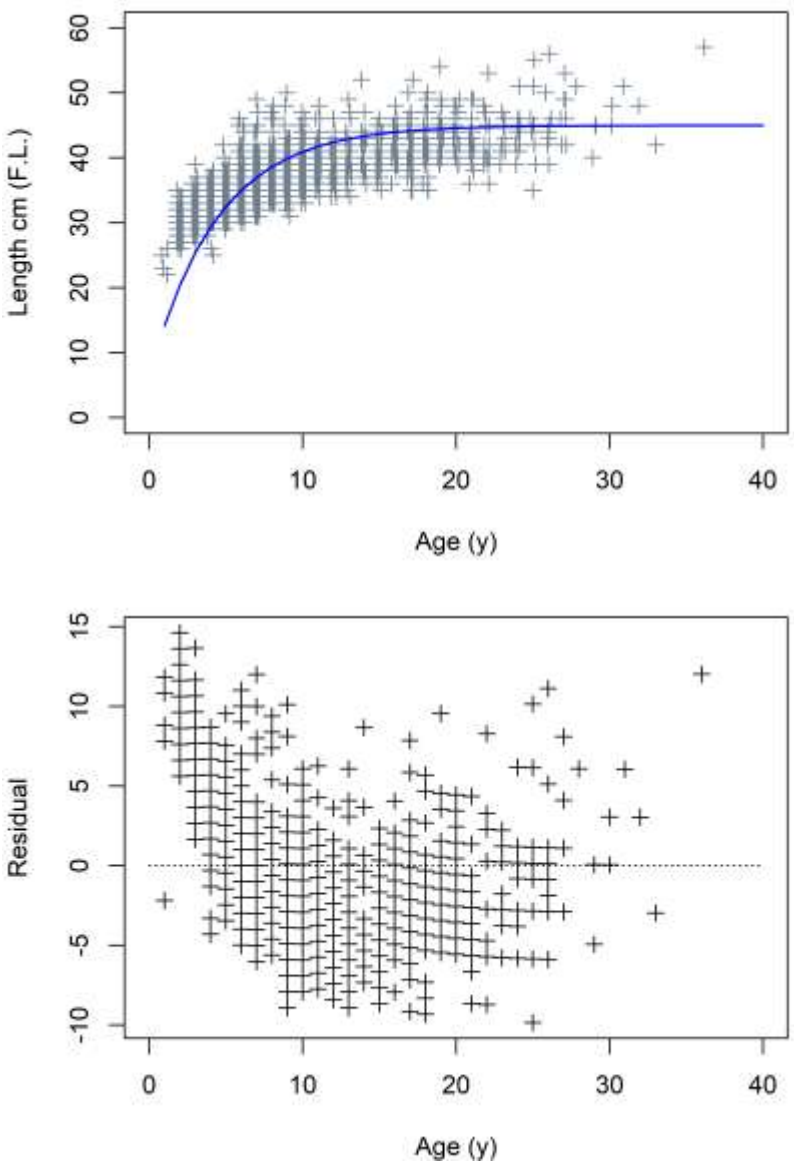


Figure 22: Estimated Von Bertalanffy growth for northern (NMB and KMNTB) TRE 7 trevally (top panel) and model residuals (bottom panel).

4.4 Trawl survey data

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 northern area off Ninety Mile Beach. 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 (initially 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 was defined encompassing an area approximating the combined area of KMNTB and NMB inside the 100 m depth contour and excluding the full extent of the Māui dolphin trawl exclusion area. A total of eight surveys encompassed the core area. For each survey, trevally biomass indices and scaled length compositions were determined following Francis & Fu (2012). In addition, the scaled number of 1 year old fish was determined based on the trevally within the 9–15 cm length range.

There is considerable variability in the biomass indices between surveys and no apparent difference in the overall magnitude of biomass indices between the two time periods (1991–1999 and 2018–2022) (Table 4 and Figure 23). The surveys predominantly sampled fish in the 25–40 cm length range. Survey estimates of the number of 1 year old fish are very imprecise (Table 4).

Trawl survey biomass indices were also derived for the South Taranaki Bight area encompassed by five of the WCNI *Kaharoa* trawl surveys. The biomass indices are variable between surveys with relatively high CVs (Table 4).

Table 4: Trevally biomass (t) indices (and CV) and 1-year indices (number, thousands) for the northern and southern areas of the *Kaharoa* WCNI surveys.

Survey	Year	Model Year	Northern (t)	CV	Number 1Y (1000s)	CV	Southern (t)	CV
KAH9111	1991	1992	1 026	0.25	3.1	2.39	508	0.50
KAH9410	1994	1995	508	0.49	37.8	0.76	-	
KAH9615	1996	1997	315	0.35	96.2	0.59	-	
KAH9915	1999	2000	626	0.54	88.8	9.26	-	
KAH1806	2018	2019	587	0.19	62.1	1.83	2 304	0.66
KAH1906	2019	2020	555	0.35	10.1	1.91	121	0.48
KAH2005	2020	2021	1 173	0.30	72.1	0.71	464	0.48
KAH2205	2022	2023	682	0.49	1.9	3.49	2 031	0.65

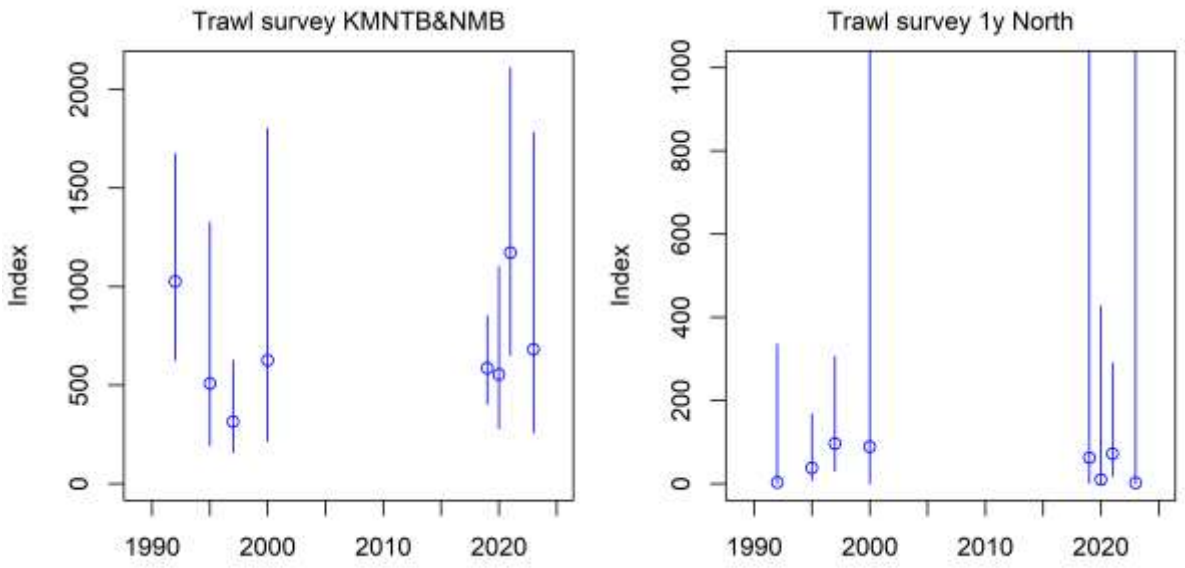


Figure 23: Trevally trawl survey biomass indices (left) and 1 year old recruitment indices (right).

5. STOCK ASSESSMENT

5.1 Stock structure

The differences in recent trends in CPUE indices and age compositions between the northern (NMB and KMNTB) and southern (STB) areas of TRE 7 indicated differences in stock dynamics between the two areas. Based on those differences the two areas are considered to support separate sub-stocks.

The base assessment model encompassed the northern (KMNTB and NMB) area only. A separate spatially structured model was also configured to include both the northern and southern areas with different growth functions and recruitments for the two areas and limited movement between areas.

5.2 Model structure

The stock assessment models were implemented in Stock Synthesis (version V3.30.23.1) (Methot & Wetzel 2013, Methot et al. 2023). The age structured population model encompassed the 1975–2025 period. The model structure combined the two sexes and included 1–39 year age classes and an accumulating age class for older fish (40+ years). The age structure of the population at the start of the model was assumed to be in an exploited, equilibrium state with the initial fishing mortality estimated (no prior).

The biological parameters (growth and age/size at maturity) were updated outside of the assessment model using recent data and were estimated as a combined sex model (see Table 5). For the base model, natural mortality was invariant with age at a value of 0.1. The value of M was derived from the equation M = loge100/maximum age, assuming a maximum age of 45 years for trevally (Hanchet 1999).

A Beverton-Holt spawning stock recruitment relationship (SRR) was assumed with steepness (h) fixed at 0.80 and the standard deviation of the natural logarithm of recruitment (σ_R) was fixed at 0.6. Recruitment deviates were estimated for the 1975–2023 years. Initial recruitment deviates for 1960–1974 were estimated to configure the initial (1975) population age structure.

Table 5: Biological parameters for the base assessment model (both sexes combined).

Parameter	Value
Natural mortality	0.10 y^{-1}
Growth parameters (Von-Bert)	*L1* 13.64 cm, *Linf* 44.99 cm, *k* 0.225
Length-wt	*a* 3.471e-05, *b* 2.826
Proportion mature	Age based Ages 1–3, 0; Age 4, 0.5; Ages 5+, 1.0
SRR steepness	*h* 0.8
SigmaR	σR 0.6

Separate fishery selectivities were estimated for the KMNTB bottom trawl fishery (logistic) and the NMB trawl fishery (double normal parameterisation). The pair trawl fishery shared the KMNTB bottom trawl selectivity. The *Kaharoa* trawl survey selectivity was estimated as a double normal (age specific) function.

The model was fitted to: (a) the KMNTB bottom trawl CPUE index for the years 1994 to 2025, (b) a market sampling proportions-at-age series covering 1975, 1976, 1978 and 1979, (c) a commercial proportions-at-age series for 1997 to 2024, (d) *Kaharoa* trawl survey biomass indices and length compositions and trawl survey 1 y juvenile abundance indices (Table 6). The weighting of the individual data sets followed the approach of Francis (2011) using Method TA1.8 to determine the final Effective Sample Size (ESS) for the age composition data.

The KMNTB CPUE index was the primary index of abundance. Initial model options also included the NMB CPUE indices although the model did not fit the magnitude of the increase in the indices. The KMNTB index was preferred because this fishery has accounted for a high proportion of the northern TRE 7 catch and catches a broader range of age classes compared to the NMB fishery. The KMNTB CPUE index series had an average CV of 13% and process error of 10% was added to each index observation (Table 6). The CPUE index was linked to the vulnerable biomass of the KMNTB bottom trawl fishery.

Table 6: The observational data included in the base assessment model and the associated CV (including process error) and ESS of the abundance indices and compositional data.

Data set	Period	CV or ESS
KMNTB CPUE indices	1994-2025	0.21–0.31
Trawl survey biomass	1992, 1995, 1997, 2000, 2019, 2020, 2021, 2023	0.19–0.54
Trawl survey 1Y	1990, 1992, 1995, 1997, 2000, 2019, 2020, 2021, 2023	0.59-3.49
BPT age comp	1975, 1976, 1978, 1979, 1998, 1999, 2001	26
KMNTB age comp	1998–2001, 2006–2008, 2010, 2013, 2023, 2024	5.9–27.8
NMB age comp	1998–2001, 2007–2008, 2010, 2013, 2023, 2024	8.1–43.2
Trawl survey length comp	1992, 1995, 1997, 2000, 2019, 2020, 2021, 2023	1

During model development, a range of options was investigated to examine the key structural assumptions of the model. The most influential assumption was the value of natural mortality, and lower and higher values of natural mortality (0.075 and 0.125) were included as key model sensitivity trials. Additional sensitivity trials bracketed the assumed value of steepness for the SRR (0.7 and 0.9).

The base model encompassed the northern (KMNTB and NMB) area only, i.e. was a stock assessment of northern sub-stock. The base assessment model included catches from the northern area only (i.e. excluded the STB catch).

The spatial stratification of the TRE 7 Fishstock was based on recent differences in the age composition and CPUE indices between the northern sub-areas and the STB sub-area. A Two Region spatially structured model was implemented with different growth functions for the two areas and limited movement between the two areas. This model included the entire catch from TRE 7. For the recent period (2010–2022), recruitments were allowed to vary between the two areas, accommodating the differences in CPUE index series and age compositions. Seasonal movement was also estimated between the two sub-stocks.

5.3 Parameter estimates

For the base northern model, full selectivity was estimated at age 4 years and 5 years for the BPT and KMNTB trawl fisheries, respectively (Figure 24). The selectivity of the NMB trawl fishery was lower for fish older than 7 years, reflecting the lower proportion of older fish in the age compositions. The *Kaharoa* trawl survey primarily sampled 4–6 year old fish; younger fish were poorly sampled by the survey and few large fish (greater than 40 cm) were caught.

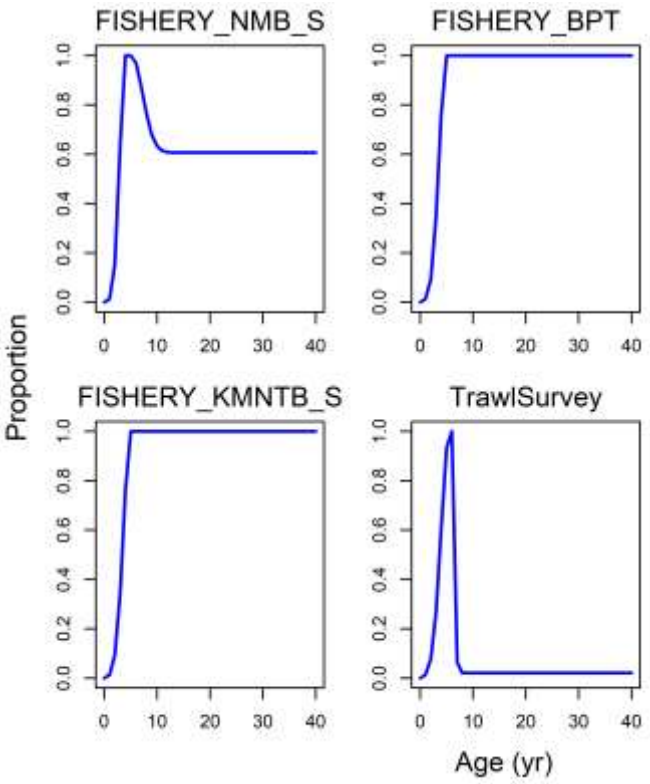


Figure 24: Age specific selectivity functions for commercial fisheries and surveys.

Recruitment deviates were estimated for two periods: the main series of recruitment deviates during the model period (1975–2023) and a period of early deviates (1960–1974) that contributed to the estimation of the initial age structure in 1975. The early deviates were estimated to be below average, particularly for the 1969–1974 year classes, i.e. the youngest age classes in the initial (1975) population (Figure 25).

For the main recruitment deviates, the estimated deviates from 1975–1990 were highly uncertain (Figure 25) due to the limited data (age composition and abundance) from the early period. Annual recruitments fluctuated during 1994–2007 followed by a period of lower recruitment in 2008–2015 and higher recruitment in 2016 and 2019–2021 (Figure 25).

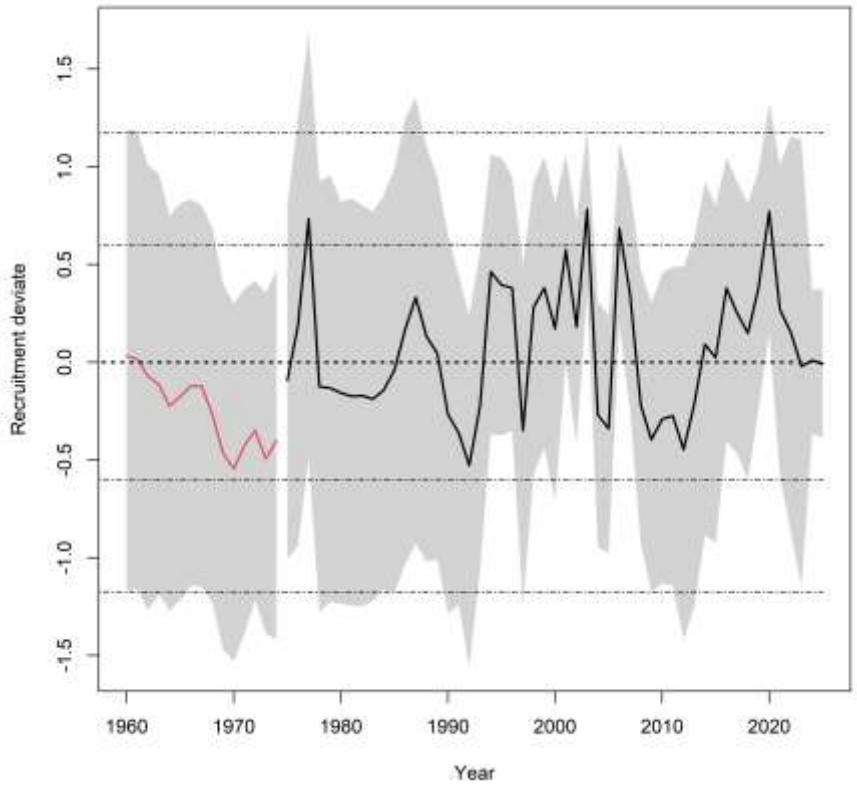


Figure 25: Annual recruitment deviates (median values) and 95% confidence intervals derived from MCMCs. The black line represents the median of the MCMC estimates and the shaded error represents the 95% confidence interval. The early recruitment deviates (1960–1974) were estimated to inform the initial population age structure (in 1975) (red line).

The initial population age structure was also informed by the estimate of initial fishing mortality (Figure 26). While the model estimate is relatively uncertain (mean 0.066, standard deviation 0.026), the result is consistent with a moderate level of depletion associated with the overall magnitude of catch prior to 1975.

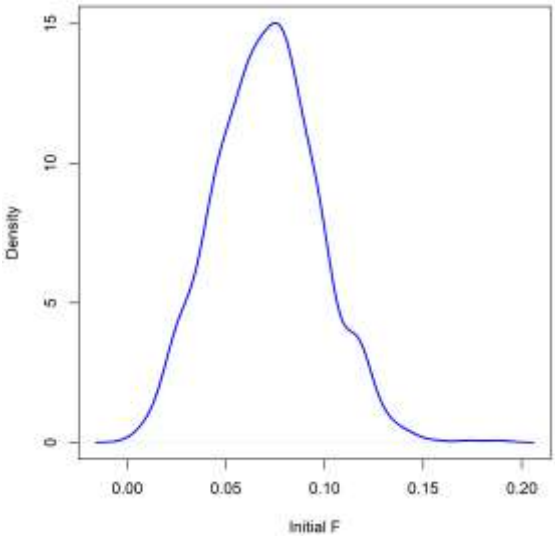


Figure 26: Density plot of the posterior distribution of the estimate of initial fishing mortality (from MCMCs).

5.4 Diagnostics

For the base model, the initial population structure was informed by the BPT age compositions from the late 1970s. The model provides a reasonable fit to the proportion of older fish in the age compositions (Figure 27 and Figure 28), although there are considerable differences in the age compositions between years, most notably between 1978 and 1979 (Figure 27). Consequently, the data are relatively uninformative regarding the variation in annual recruitments in the preceding years (estimated from 1960 onwards).

The base northern TRE 7 model fits the general trend in the KMNTB trawl CPUE indices, although the model under-estimates the variation in the indices, particularly the magnitude of the higher indices (Figure 29). The inter-annual variation in abundance is constrained by the age composition data from the fishery (Figure 30). Overall, the model provides a good fit to the KMNTB single trawl age compositions (Figure 30 and Figure 31).

The estimates of recent strong recruitments are informed by the high proportion of younger (3–8 years old) fish in the KMNTB age compositions from 2023 and 2024 in conjunction with the higher CPUE indices for those years. The strong recruitments are also consistent with the high proportions of 3–5 year old fish in the 2023 and 2024 NMB age compositions (2019 and 2020 year classes) (Figure 32 and Figure 33).

The model provides a good fit to the *Kaharoa* trawl survey biomass indices from the two periods (1992–2000 and 2019–2023) (Figure 29). The survey selectivity is estimated from the associated length composition data, although these observations are given a very low weighting in the model. The fits to the individual survey length compositions are poor, especially for the smaller fish (less than 25 cm) (Figure 34). Fish in this length range were poorly sampled by the survey, as evident from the very high CVs associated with the trawl survey 1 year old recruitment index. This index was uninformative in the estimation of annual recruitments (Figure 29).

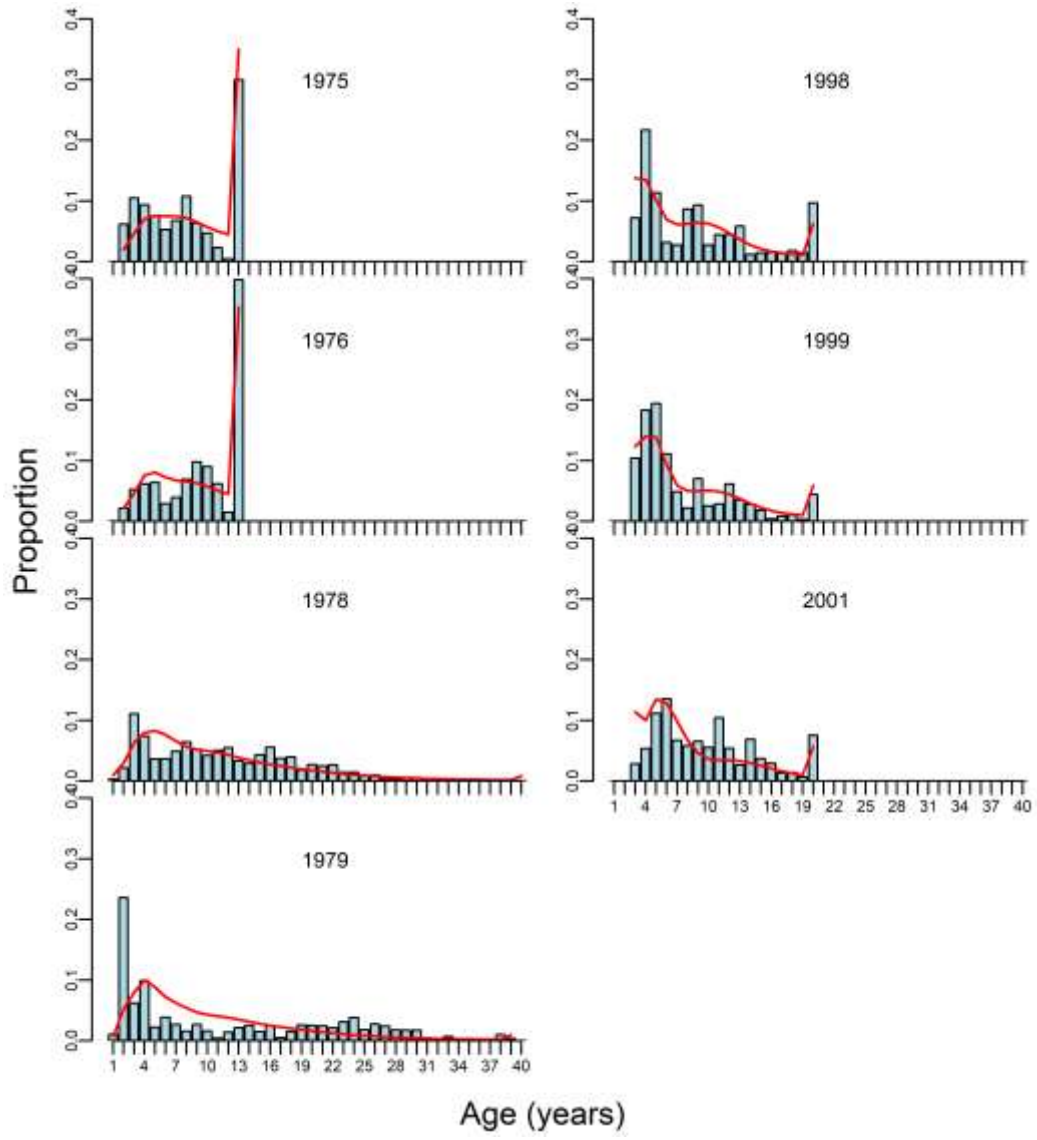


Figure 27: Observed (bars) and predicted (red lines) proportions at age (both sexes combined) from the BPT fishery.

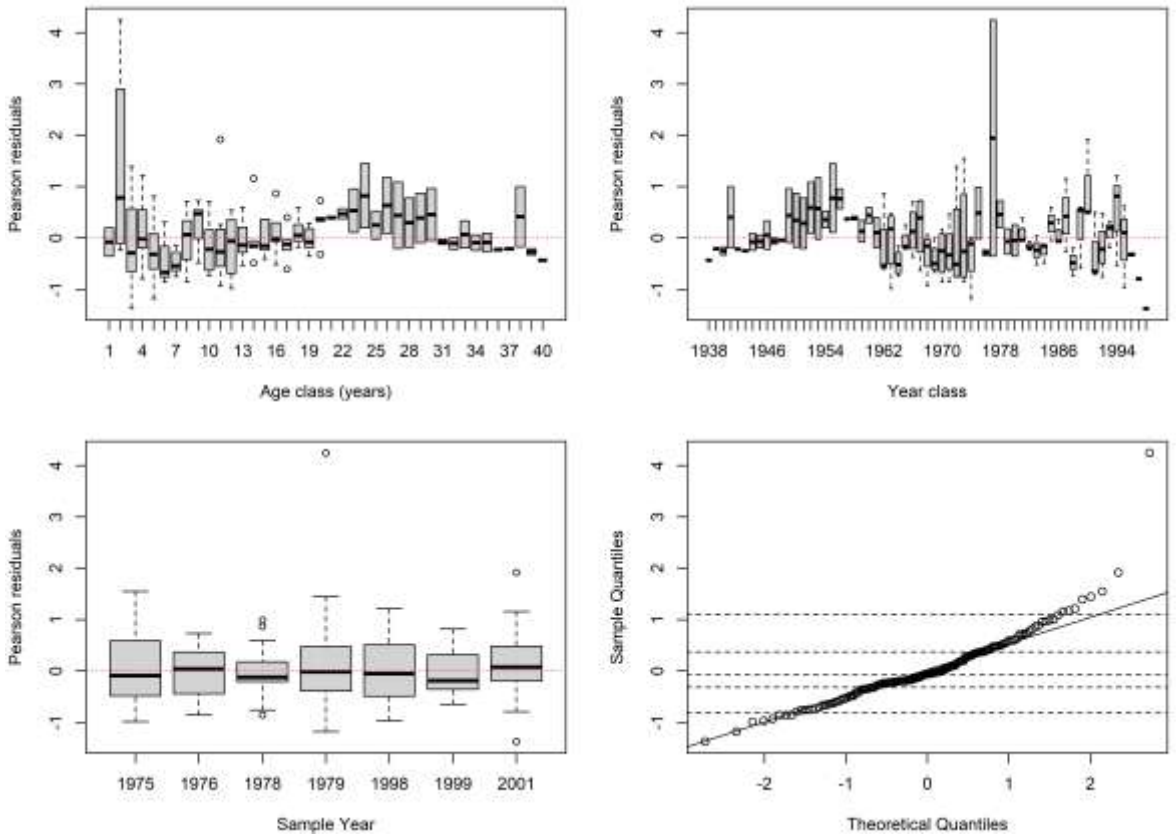


Figure 28: Residuals for the model fits to the proportions at age from the BPT fishery by age class, year class and sample year. The quantile plot for the distribution of the residuals is also presented (lower right panel).

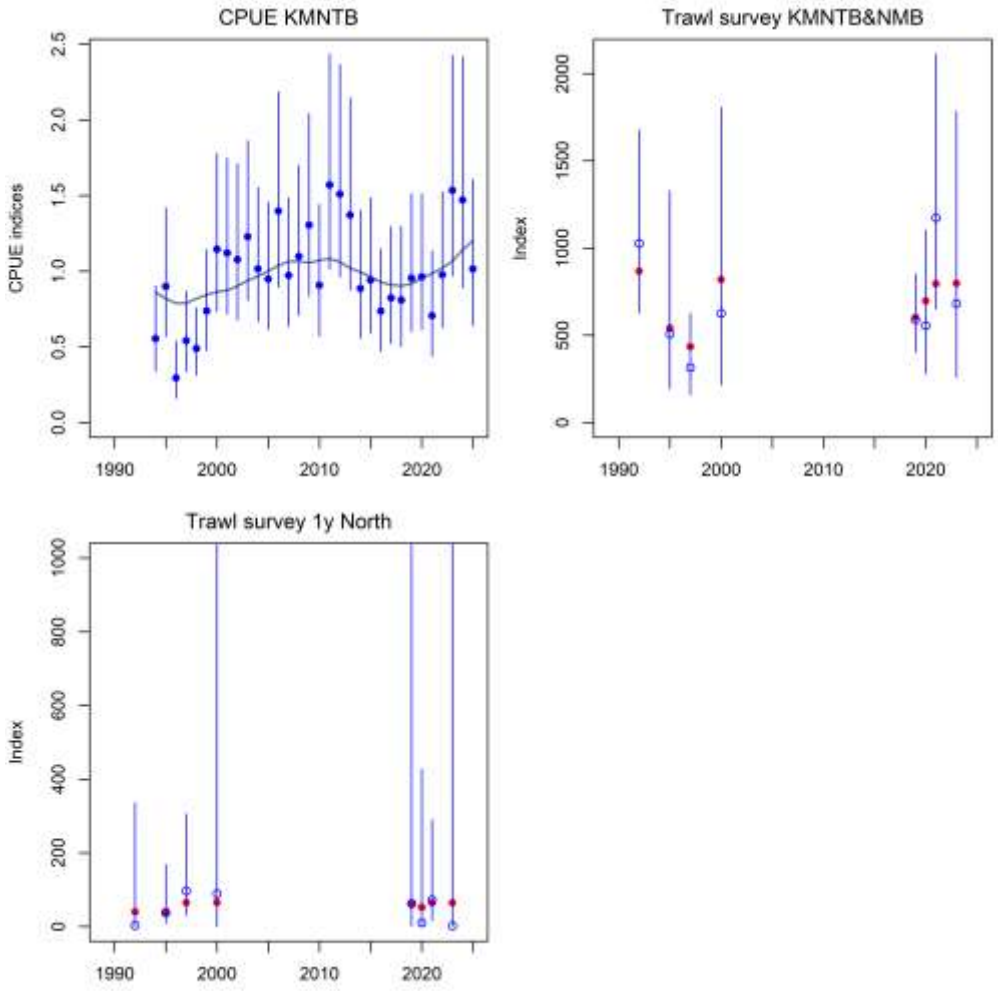


Figure 29: Fit to the abundance indices included in the northern TRE 7 base model.

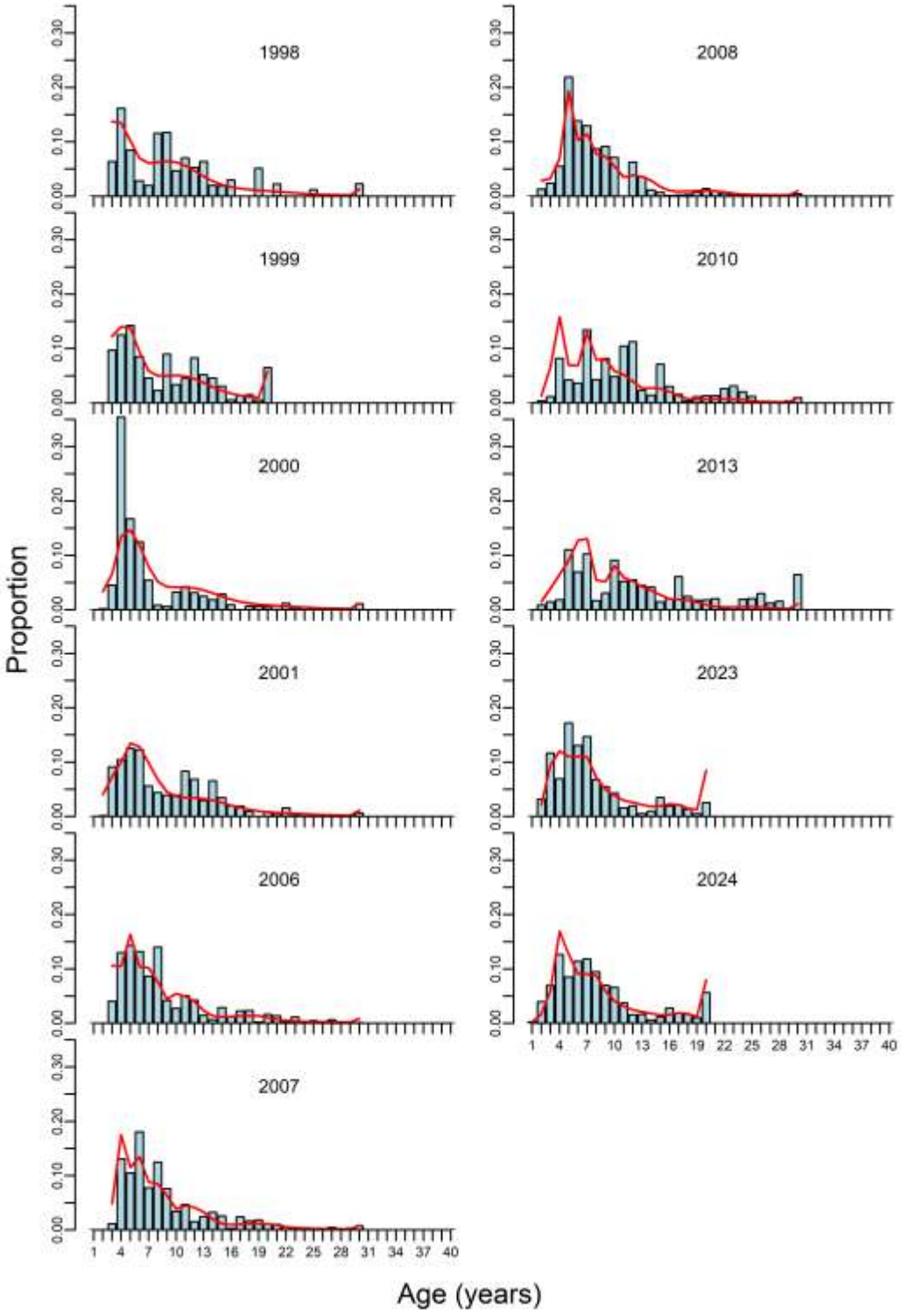


Figure 30: Observed (bars) and predicted (red lines) proportions at age (both sexes combined) from the KMNTB trawl fishery.

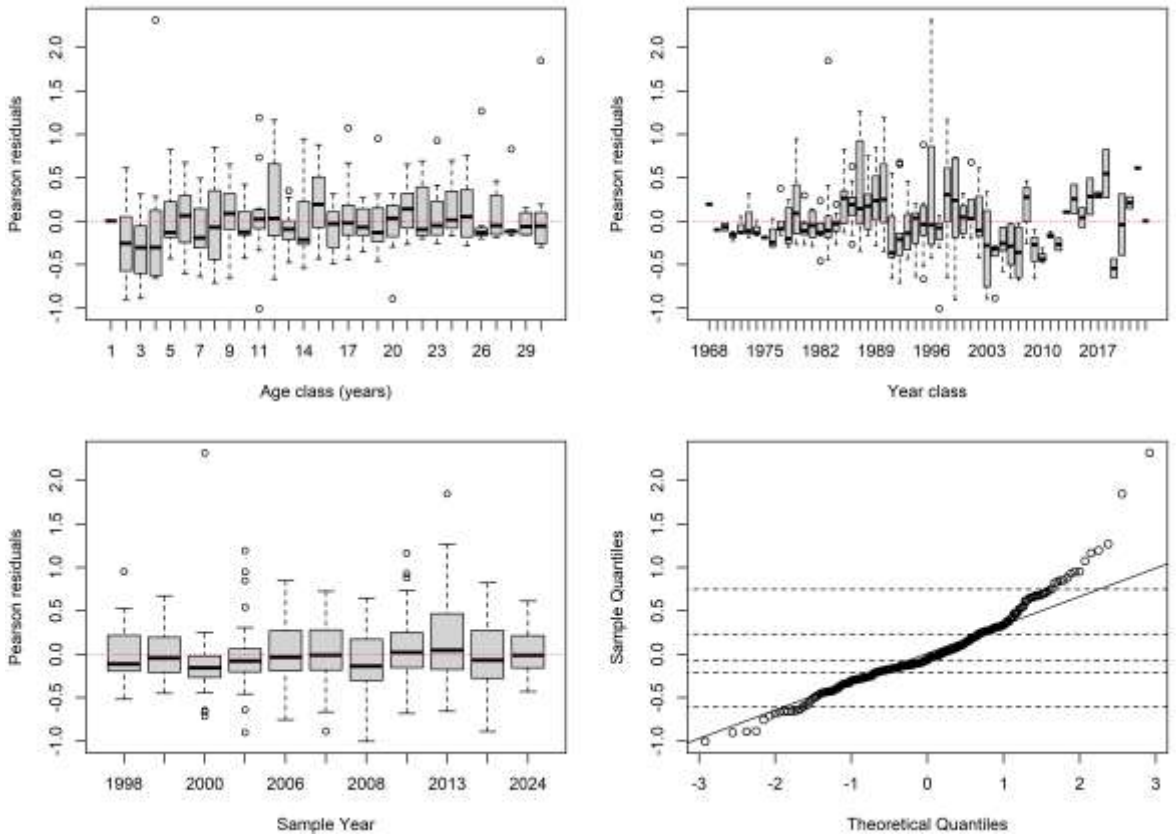


Figure 31: Residuals for the model fits to the proportions at age from the KMNTB single trawl fishery by age class, year class and sample year. The quantile plot for the distribution of the residuals is also presented (lower right panel).

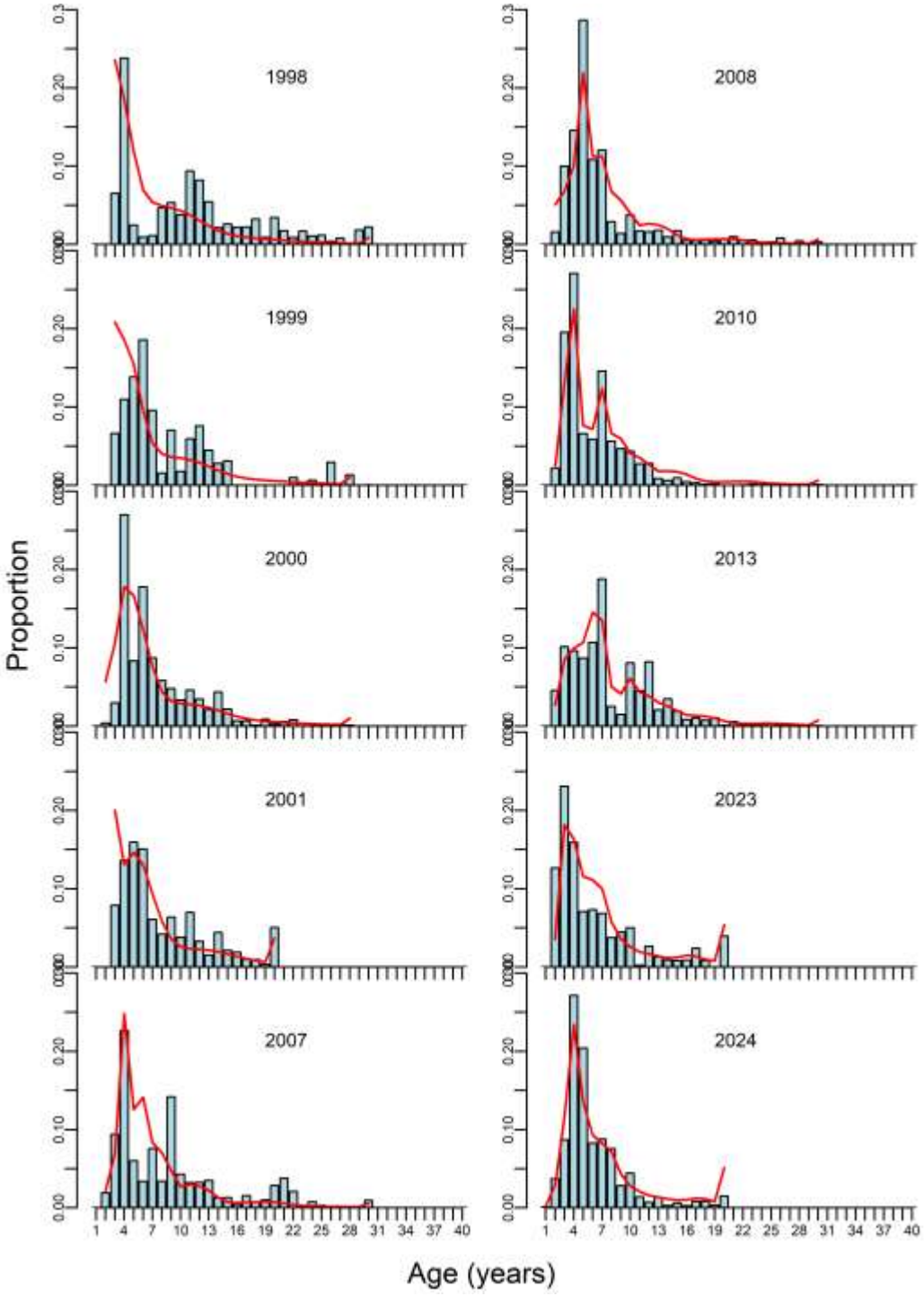


Figure 32: Observed (bars) and predicted (red lines) proportions at age (both sexes combined) from the NMB trawl fishery.

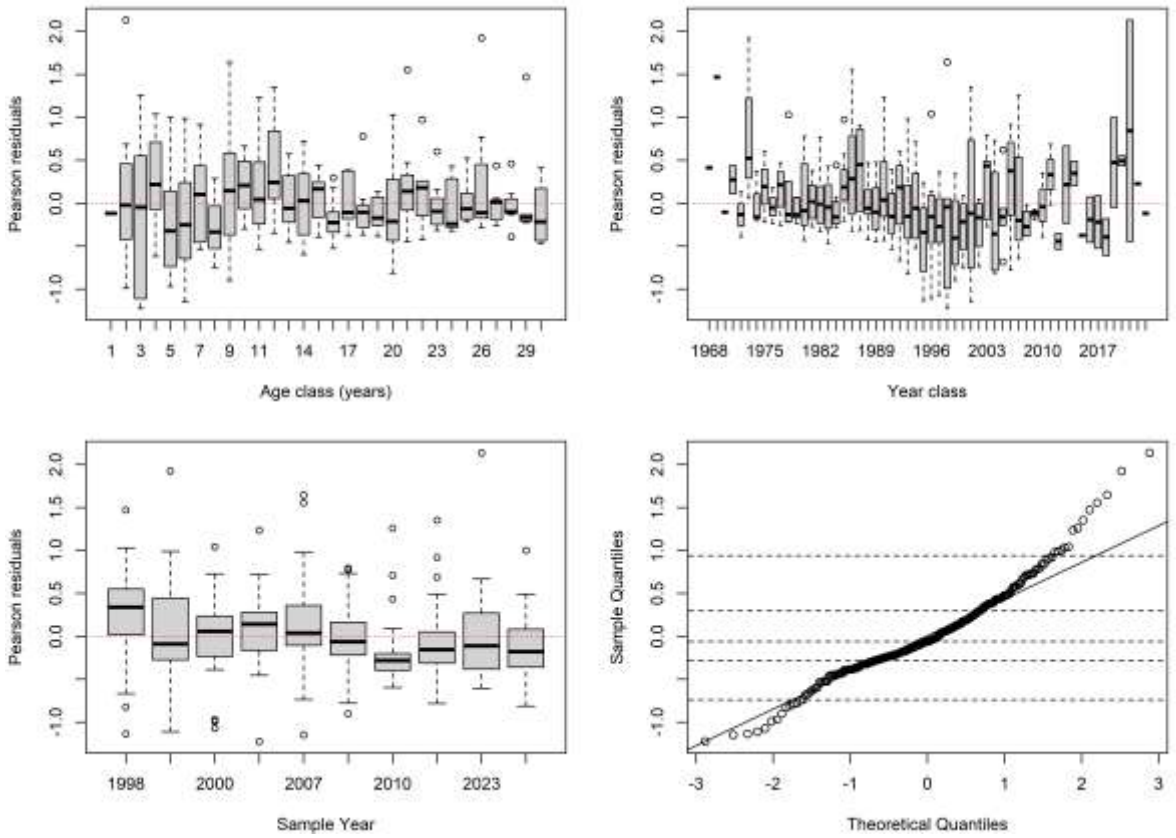


Figure 33: Residuals for the model fits to the proportions at age from NMB single trawl fishery by age class, year class and sample year. The quantile plot for the distributions of the residuals is also presented (lower right panel).

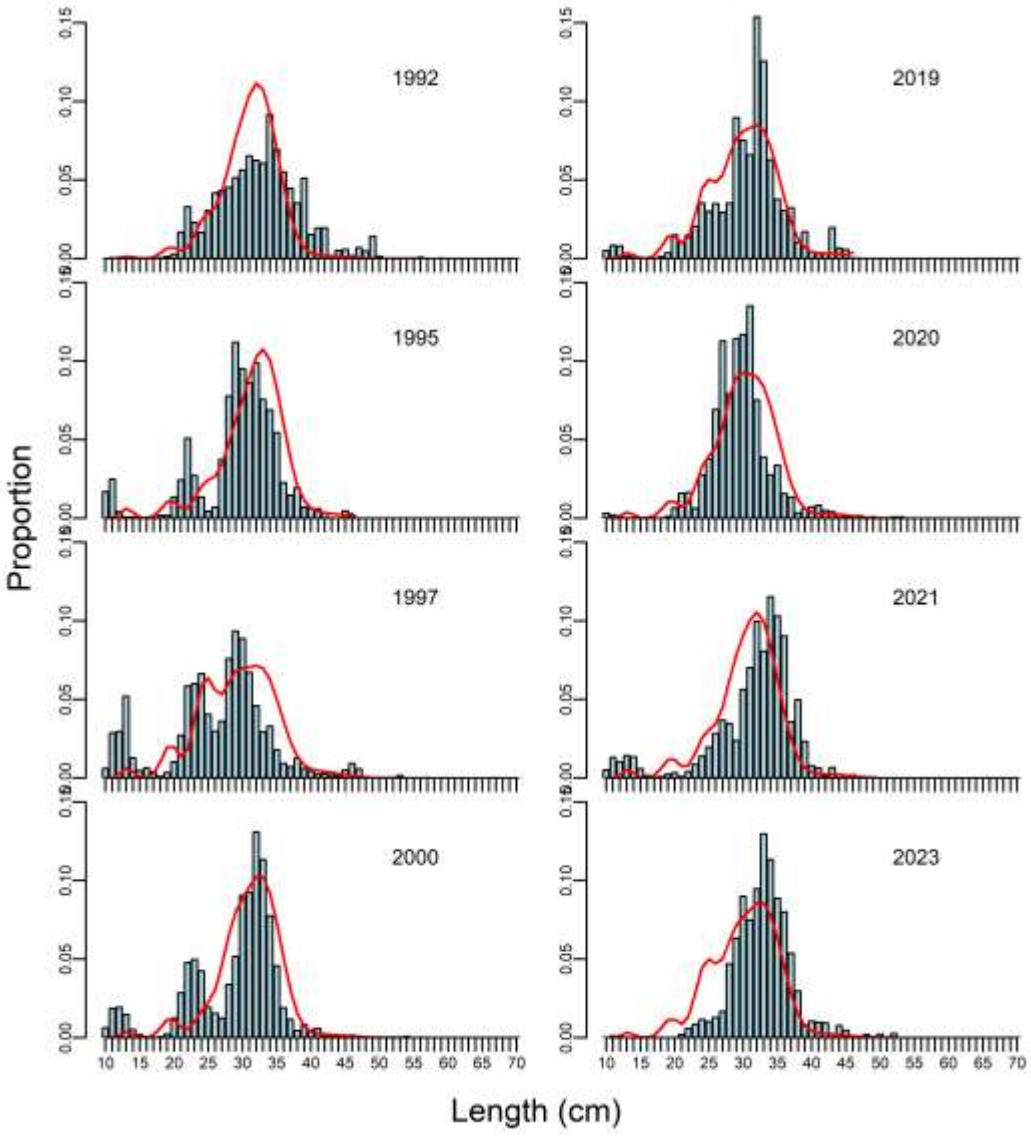


Figure 34: **Observed (bars) and predicted (red lines) proportions at length (both sexes combined) from the WCNI *Kaharoa* trawl surveys (northern TRE 7).**

5.5 Stock dynamics

The base assessment model estimated that spawning biomass in 1975 had declined to 53% of the virgin biomass level. The extent of the reduction in the spawning biomass was informed by the 1970s age composition data from the bottom pair trawl (BPT) fishery. The proportion of older fish included in the age composition provide information regarding the level of fishing mortality in the preceding period, given the constant value of *M*. Thus, the level of depletion will be influenced by the assumed value of *M* (i.e., higher depletion with lower *M*).

For the northern sub-stock, spawning biomass remained relatively stable during the 1980s and 1990s (Figure 35). From 2000, there was a general increase in stock abundance, with a sharp increase in biomass over recent (2021–2025) years, attributable to higher recent recruitments (Figure 36) and a reduction in commercial catches.

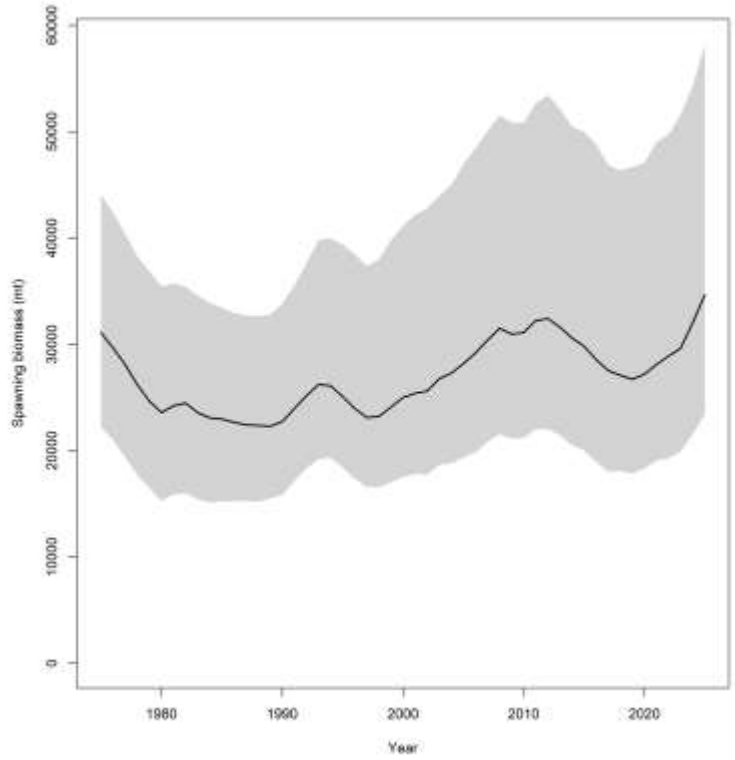


Figure 35: Annual spawning biomass (female, tonnes) from the base northern TRE 7 assessment model. The shaded grey area represents the 95% confidence interval.

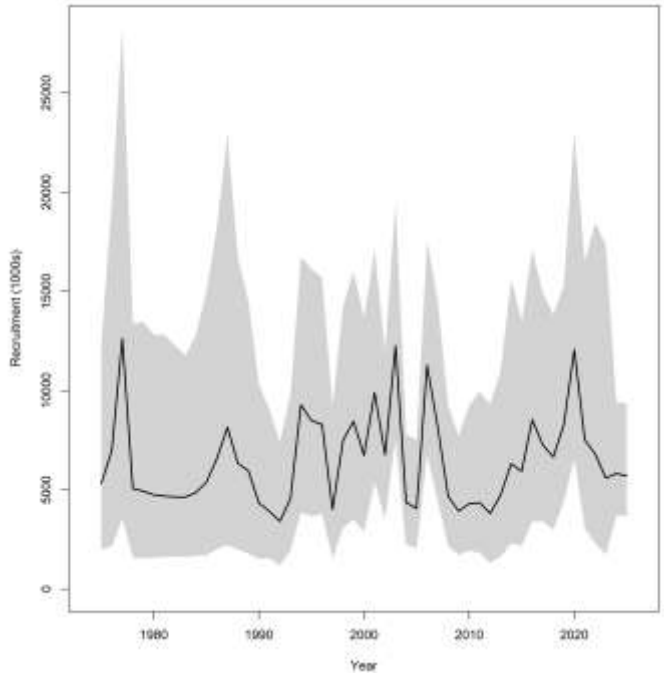


Figure 36: Annual recruitments (in thousands of fish) from the base northern TRE 7 assessment model. The shaded grey area represents the 95% confidence interval.

The Two Region model estimated that the southern sub-stock included about 15–20% of the total TRE 7 spawning biomass (Figure 37). However, over the last decade the magnitude of the southern sub-stock biomass is estimated to have increased considerably due to increased recruitment in the region since 2010 (Figure 37). The magnitude of the increase in southern sub-stock biomass was informed by the increase in event-based CPUE indices from the STB trawl fishery, supported by age composition data from the fishery.

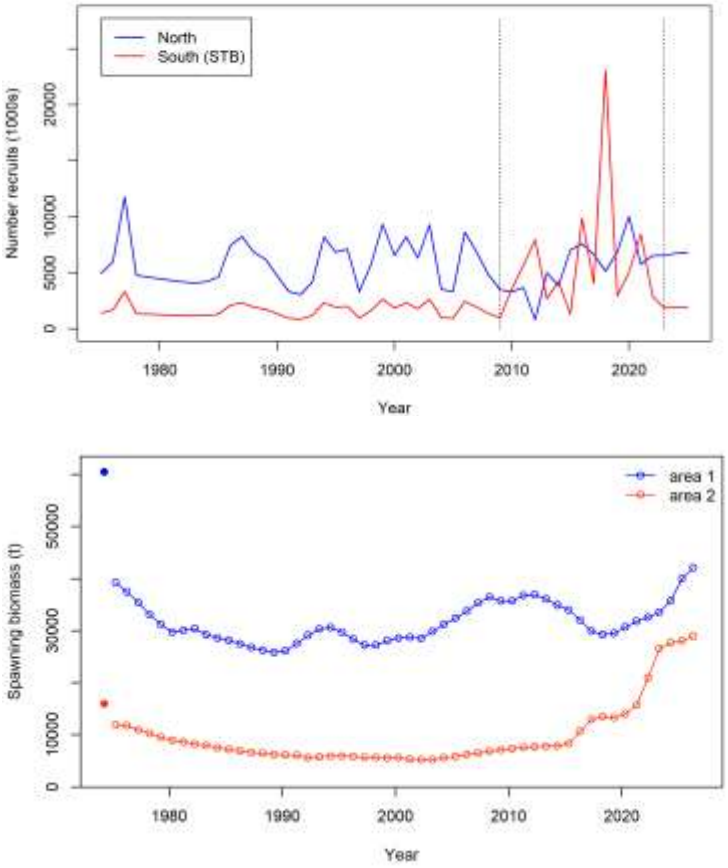


Figure 37: Estimates of annual recruitments (top panel) and spawning biomass for the Northern (area1, blue) and Southern (area 2, red) areas of the Two Region model.

However, there are limited data available to support the spatial complexity of the Two Region model, particularly the estimation of seasonal movement parameters and regional recruitment variability. Further, the series of CPUE indices from the Southern area was considered to be less reliable than the Northern KMNTB CPUE index, due to the shorter time series (2008–2025) and changes in the operation of the fishery over the last five years. For these reasons, the Two Region model was not considered to be sufficiently robust to provide a reliable estimate of the status of the overall TRE 7 stock. Instead, the model was retained as a sensitivity trial to demonstrate the likely spatial dynamics within the wider TRE 7 area.

5.6 Stock status

The stock status of the northern sub-stock of TRE 7 has been assessed relative to a default target biomass level of 40% SB_0 and associated soft limit and hard limits of 20% and 10% SB_0 (Ministry of Fisheries 2008). Stock status conclusions are specific to the area encompassed by the base assessment model (i.e., Northern). For the base model, spawning biomass was maintained at about the target biomass level during the 1980s and 1990s. From 2000, spawning biomass increased to above the target level (Figure 38). Current (2024–25) biomass (SB_{2025}) is estimated to be well above the target biomass level (Table 7).

Current levels of fishing mortality are estimated to be well below the $F_{SB40\%}$ level for all model options (Table 8 and Figure 39).

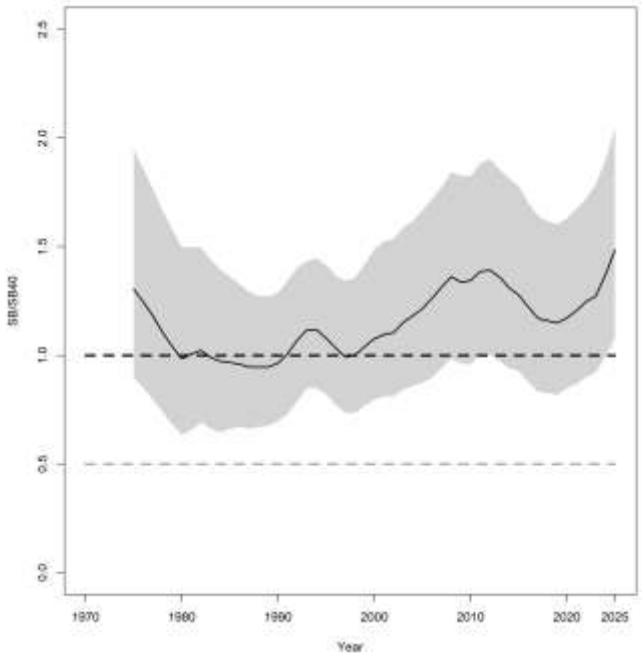


Figure 38: **Spawning biomass relative to the default target biomass (40% SB_0) from MCMC model fits for the base model, with 95% credible intervals.**

Table 7: **Biomass and yield estimates (medians, with 95% confidence intervals in parentheses) for the base model and sensitivity trials. Estimates are derived from MCMC analysis. Model results are limited to the Northern area of TRE 7, except for the TwoRegion sensitivity trial which represents the entire TRE 7 area.**

Model option	SB_0	SB_{2025}	$SB_{40\%}$	SB_{2025}/SB_0	$SB_{2025}/SB_{40\%}$
Base	58 862 (45 728–80 440)	34 648 (23 425–58 260)	23 545 (18 291–32 176)	0.594 (0.432–0.82)	1.485 (1.08–2.049)
M low	67 015 (52 968–87 366)	28 093 (19 800–44 080)	26 806 (21 187–34 946)	0.422 (0.306–0.595)	1.054 (0.764–1.487)
M high	62 459 (45 343–100 337)	47 182 (28 880–89 310)	24 983 (18 137–40 135)	0.76 (0.564–1.026)	1.9 (1.41–2.566)
Steep70	63 306 (48 001–86 532)	36 131 (23 876–59 910)	25 322 (19 200–34 613)	0.575 (0.408–0.787)	1.439 (1.02–1.968)
Steep90	56 775 (44 336–79 477)	34 904 (23 292–58 675)	22 710 (17 734–31 791)	0.62 (0.455–0.837)	1.549 (1.138–2.091)
TwoRegion	77 255 (59 220–110 677)	69 781 (44 827–124 723)	30 902 (23f688–44 271)	0.91 (0.661–1.257)	2.275 (1.651–3.142)

Table 8: **Estimates of target fishing mortality ($F_{SB40\%}$) and current fishing mortality (F_{2025}) relative to the target level (medians, with 95% confidence intervals in parentheses) for the base model and sensitivity trials. Estimates are derived from MCMC analysis. Model results are limited to the Northern area of TRE 7, except for the TwoRegion sensitivity trial which represents the entire TRE 7 area.**

Model option	$F_{SB40\%}$	$F_{2025}/F_{SB40\%}$	$Pr\ (F_{2025}<F_{SB40\%})$
Base	0.072	0.368 (0.226–0.536)	1.00
M low	0.058	0.575 (0.371–0.799)	1.00
M high	0.086	0.224 (0.120–0.359)	1.00
Steep70	0.066	0.387 (0.241–0.576)	1.00
Steep90	0.078	0.339 (0.207–0.493)	1.00
TwoRegion	0.076	0.235 (0.135–0.364)	1.00

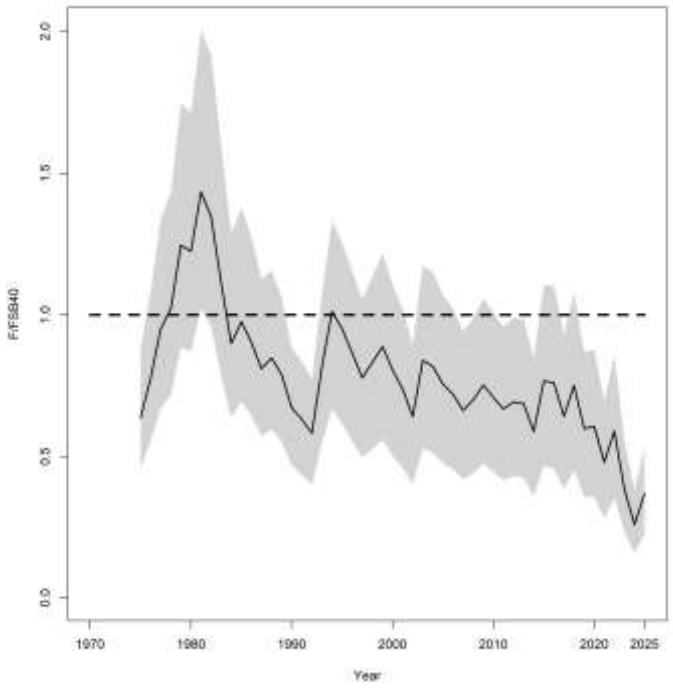


Figure 39: **Fishing mortality relative to the overfishing threshold ($F_{SB40\%}$) (median of MCMCs) for the base model run. 95% credible intervals were derived from MCMC. The dashed, black horizontal line represents the default overfishing threshold.**

Stock status from the model sensitivity trials is comparable to the base model, although the status is less optimistic for the *Low M* sensitivity trial (Figure 40). For the *Low M* sensitivity trial, current biomass was estimated to be at about the target biomass level with no associated risk that the stock biomass has approached the biomass limit reference points. The stock status from the *TwoRegion* model, which includes all the TRE 7 catch, was more optimistic than the base model due to the recent increase in biomass estimated for the southern sub-stock (Figure 40).

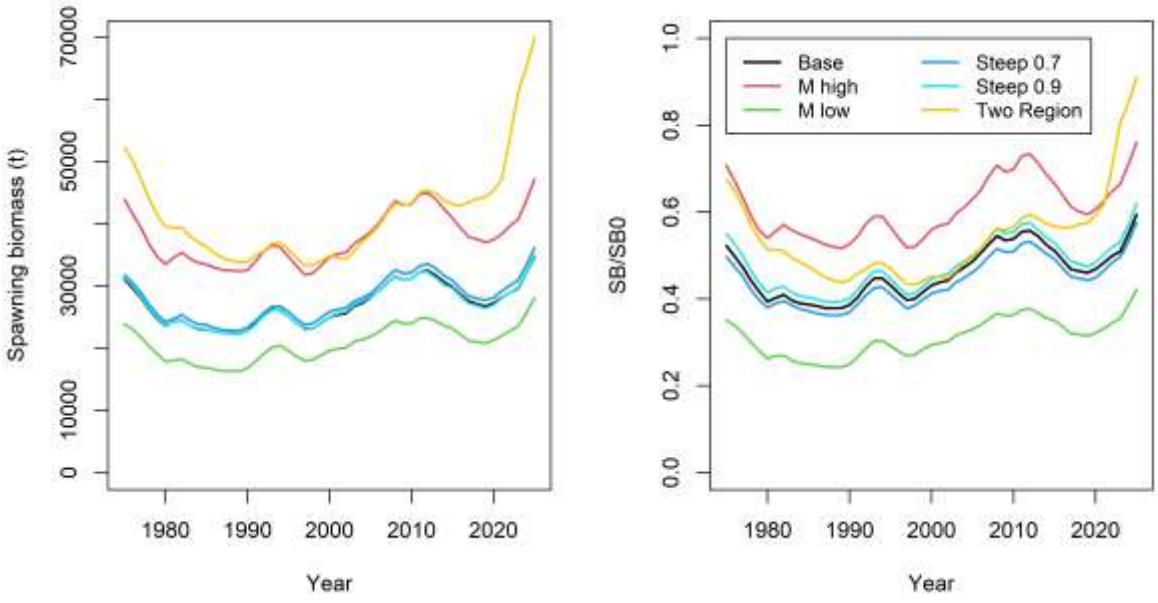


Figure 40: Median spawning biomass (female only) trajectories from MCMC model fits for the base model and sensitivity trials.

Projections

Stock projections, for a five-year period (2026–2030), were conducted for all model options at the TACC level plus allowances for unreported commercial catch (1% of TACC) and recreational and customary catch. For the northern sub-stock models the entire TACC (2153 t) was assumed to be taken in the Northern area, while for the TwoRegion model the TACC is partitioned between the two regions with 227 t assigned to the southern area (average catch from 2016–2025).

Recent recruitments (2011–2020) were estimated to be equivalent to equilibrium recruitment. In the projection period, recruitment variation was incorporated in the model with the recruitment deviates simply constrained by the assumed variation in the deviates (σ_R = 0.60).

For all model options, spawning biomass was projected to decline slightly (by 3–5%) during the projection period. There was a low probability that the biomass would decline below the target biomass level for all options, with the exception of the low *M* sensitivity trial which remained at about the target biomass level (Table 9).

Table 9: Stock status in the terminal year (2030) of the five-year forecast period based on catches at the current TACC.

Model option	SB_{2030}/SB_0	$\Pr(SB_{2030} > X\%SB_0)$		
		10%	20%	40%
Base	0.568 (0.398–0.816)	1.00	1.00	0.97
M low	0.411 (0.277–0.607)	1.00	1.00	0.57
M high	0.718 (0.505–0.997)	1.00	1.00	1.00
Steep70	0.550 (0.371–0.783)	1.00	1.00	0.96
Steep90	0.587 (0.412–0.832)	1.00	1.00	0.98
TwoRegion	0.878 (0.610–1.214)	1.00	1.00	1.00

5.7 Comparative model using Casal2

For comparative purposes, the base case model was also configured using the Casal2 software (Casal2 Development Team 2026). Almost all the features of the Stock Synthesis model were able to be replicated using Casal2, although there were differences in the configuration of the initial population state, relating to the interaction between the estimation of the initial fishing mortality rate and estimating recruitment deviates in the early years. For both Stock Synthesis and Casal2, the initial fishing mortality was estimated based on the age-based selectivity of the BPT fishery.

Those differences resulted in Casal2 estimating a slightly lower initial fishing mortality and lower initial recruitments compared to Stock Synthesis (Figure 41). This resulted in a relatively small difference in the magnitude of spawning biomass and the models rapidly converged to estimate a very similar stock status (relative to SB_0) from 1993 onwards (Figure 41). Estimates of absolute numbers of recruits were very similar for the same period (Figure 41). The similarity in these results demonstrate that the assessment results are insensitive to the modelling platform.

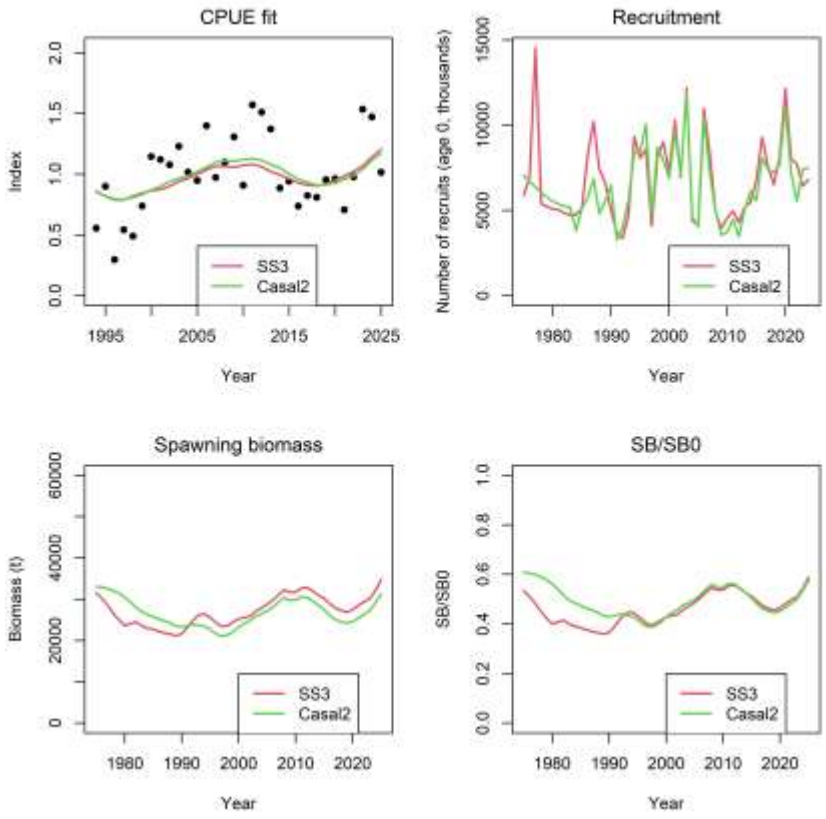


Figure 41: A comparison between the Stock Synthesis (SS3) base-case model and a comparative model implemented in Casal2.

6. DISCUSSION

Over the last decade, catches from the TRE 7 commercial fishery have declined. The decline in catch appears to be related to a decline in the targeting of trevally since 2011–12, as indicated by the reduction in trawl effort in the core area of the trevally trawl fishery. These changes correspond with an increase in the abundance of snapper off the west coast of the North Island (SNA 8) since the late 2000s (Langley 2024a). Snapper are caught in association with trevally, particularly during November-December. Consequently, the limited availability of SNA 8 ACE is likely to have increasingly constrained the ability of the trawl fleet to target trevally.

Since 2011–12, the trevally target fishery was dominated by a single vessel. The retirement of this vessel from the fishery in 2023–24 contributed to a further decline in the trevally catch in the most recent years.

The assessment represents an update and refinement of the previous TRE 7 stock assessment (Langley et al. 2015). The current assessment extended the time-series of data, with the updated CPUE indices and commercial age composition data from 2022–23 and 2023–24. The main changes to the structural assumptions of the model were: the initialisation of the model in 1975 under exploited conditions and the reconfiguration of the data from the single trawl fishery (removing the partitioning of the dominant vessel in the fleet).

The 2015 assessment included the entire catch history, initialising the model in 1944 assuming equilibrium unexploited conditions. For the current assessment, the model was initialised in 1975 by estimating the initial fishing mortality to configure the model population, while model options that included the entire catch history (from 1944) estimated equivalent levels of overall stock biomass and depletion. The model commencing in 1975 was adopted as the preferred model option as it removed the uncertainty regarding the magnitude of trevally catches from the earlier period.

For the current assessment, the estimates of virgin biomass, recent biomass and overall stock depletion were comparable to the 2015 stock assessment.

The CPUE indices from KMNTB fishery represent the main abundance index in the stock assessment. The fishery accounted for a significant proportion (50–70%) of the trevally catch from 1993–94 to 2024–25. There were significant changes in the operation of the fishery over the time period that are, at least partially, accounted for in the standardisation of the CPUE indices. However, there are likely to be more subtle associated changes in the length/age selectivity of the fishery that are not accounted for in the assessment models.

The KMNTB CPUE indices encompass a relatively limited period of the fishery. Earlier stock assessments derived CPUE indices for the period of larger catches during the 1970s and early 1980s. (Francis et al. 1999 and Hanchet 1999). However, the CPUE indices were uninformative and not included in subsequent assessments (McKenzie 2008).

The current base assessment model encompasses the northern area of TRE 7 only. Since 2003–04, the northern area accounted for about 85% of the annual TRE 7 catches. The main conclusions of the stock assessment pertain to this portion of the fishery. The recent age composition data indicated emerging differences in stock structure between the northern area and the southern portion of TRE 7, specifically, the presence of a very strong 2018 year class in the South Taranaki Bight fishery. Correspondingly, this year class was also dominant in the age compositions of snapper from South Taranaki Bight (Langley 2024b). This suggests that there are local scale processes in the South Taranaki Bight that are influencing the recruitment of both species in the area. This increases the complexity of the stock structure for both species. At this stage, there are insufficient data available to reliably assess the southern portion of the TRE 7 stock, although age composition data and CPUE indices indicate that the abundance of trevally has increased since 2020–21.

Future monitoring of TRE 7 will include further sampling of the commercial catches from the northern and southern sub-stocks, currently scheduled for 2027–28 and 2028–29, and the refinement of CPUE modelling approaches. The retirement of *Kaharoa* in 2025 ended the existing series of WCNI trawl survey biomass indices. A new time-series of WCNI and STB (part of WCSI survey) trawl surveys has been initiated using *Kaharoa II* and the utility of these surveys for monitoring trevally will be evaluated.

7. ACKNOWLEDGMENTS

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APPENDIX 1: CPUE DATA ANALYSIS – NINETY MILE BEACH

Table A1: Summary of the Ninety Mile Beach (NMB) 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	99	6	14	102.9	99	269	38.4
1994–95	176	5	22	165.3	176	538	22.7
1995–96	195	11	47	34.5	195	597	62.6
1996–97	613	12	112	206.4	613	1 833	45.2
1997–98	596	12	116	149.1	596	1 796	38.8
1998–99	549	11	88	111.5	549	1 519	35.7
1999–00	724	11	109	112.9	724	2 376	34.1
2000–01	464	12	88	73.9	464	1 639	48.3
2001–02	284	11	72	39.0	284	1 045	52.1
2002–03	265	10	67	54.6	265	1 010	59.6
2003–04	357	10	70	74.1	357	1 379	43.4
2004–05	276	9	58	133.2	276	974	34.1
2005–06	207	7	50	65.5	207	714	46.4
2006–07	240	6	45	105.5	240	811	25.4
2007–08	258	5	46	104.8	258	925	37.6
2008–09	346	4	57	247.4	346	1 226	26.3
2009–10	352	3	47	348.7	352	1 074	19.9
2010–11	380	5	68	199.9	380	1 224	29.7
2011–12	502	4	77	322.7	502	1 622	12.9
2012–13	315	4	52	160.3	315	1 035	21.0
2013–14	412	7	76	129.1	412	1 324	29.4
2014–15	609	7	104	242.6	609	2 073	22.0
2015–16	514	6	76	166.5	514	1 577	24.5
2016–17	702	7	118	221.4	702	2 392	33.6
2017–18	448	7	78	173.8	448	1 550	21.4
2018–19	445	6	74	171.7	445	1 550	11.7
2019–20	437	6	73	194.2	437	1 533	18.5
2020–21	504	5	88	320.6	504	1 758	16.7
2021–22	509	8	90	270.8	509	1 661	16.5
2022–23	317	4	54	217.4	317	1 066	21.5
2023–24	208	4	48	127.0	208	710	17.8
2024–25	239	3	50	138.9	239	872	22.6

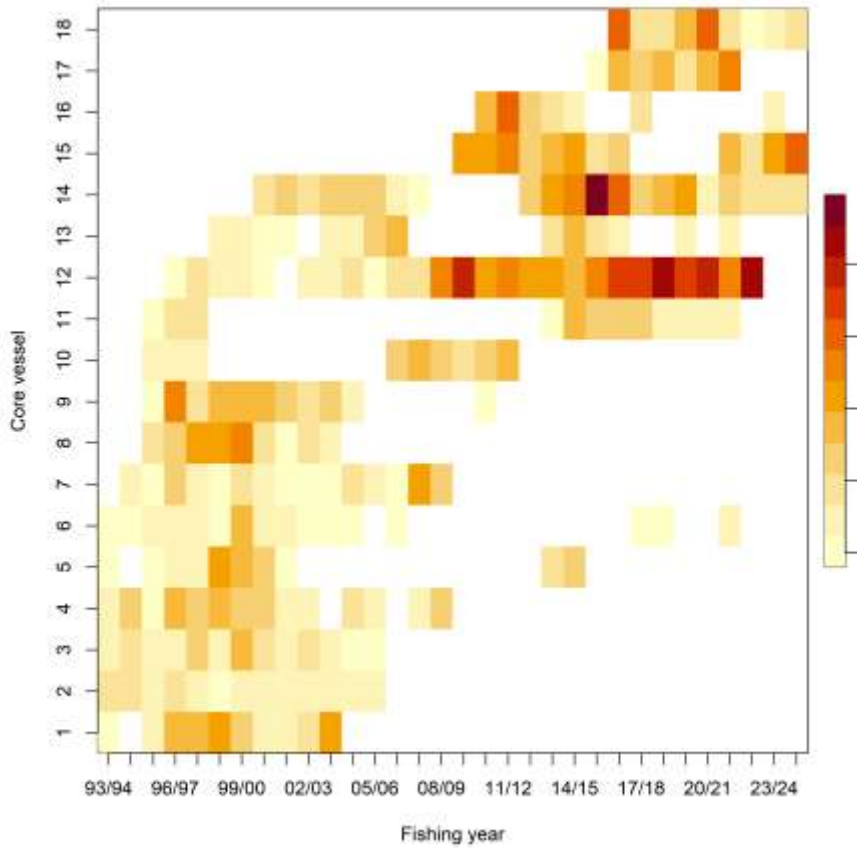


Figure A1: Annual number of trawl event records for each vessel included in the NMB Trawl core fleet. The colour of the cell represents the number of records from low (pale yellow) to high (dark red).

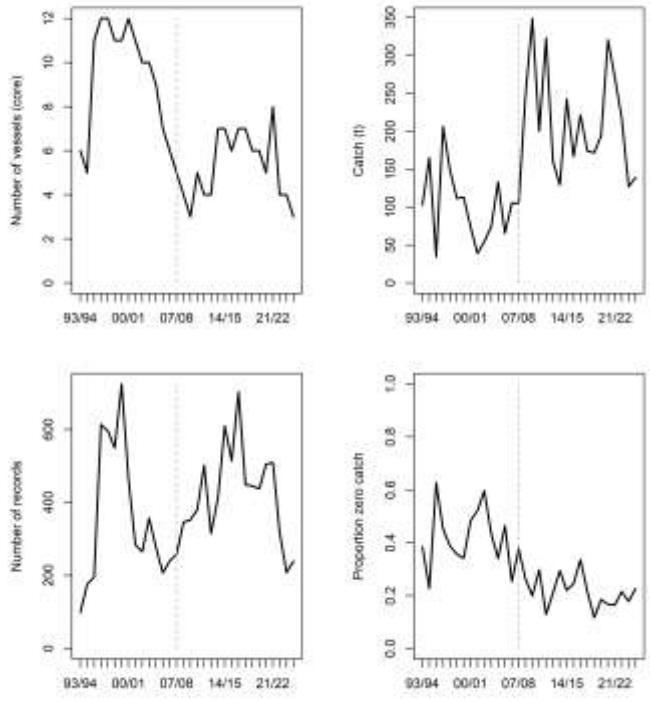


Figure A2: A summary of the data included in the NMB Trawl CPUE data set.

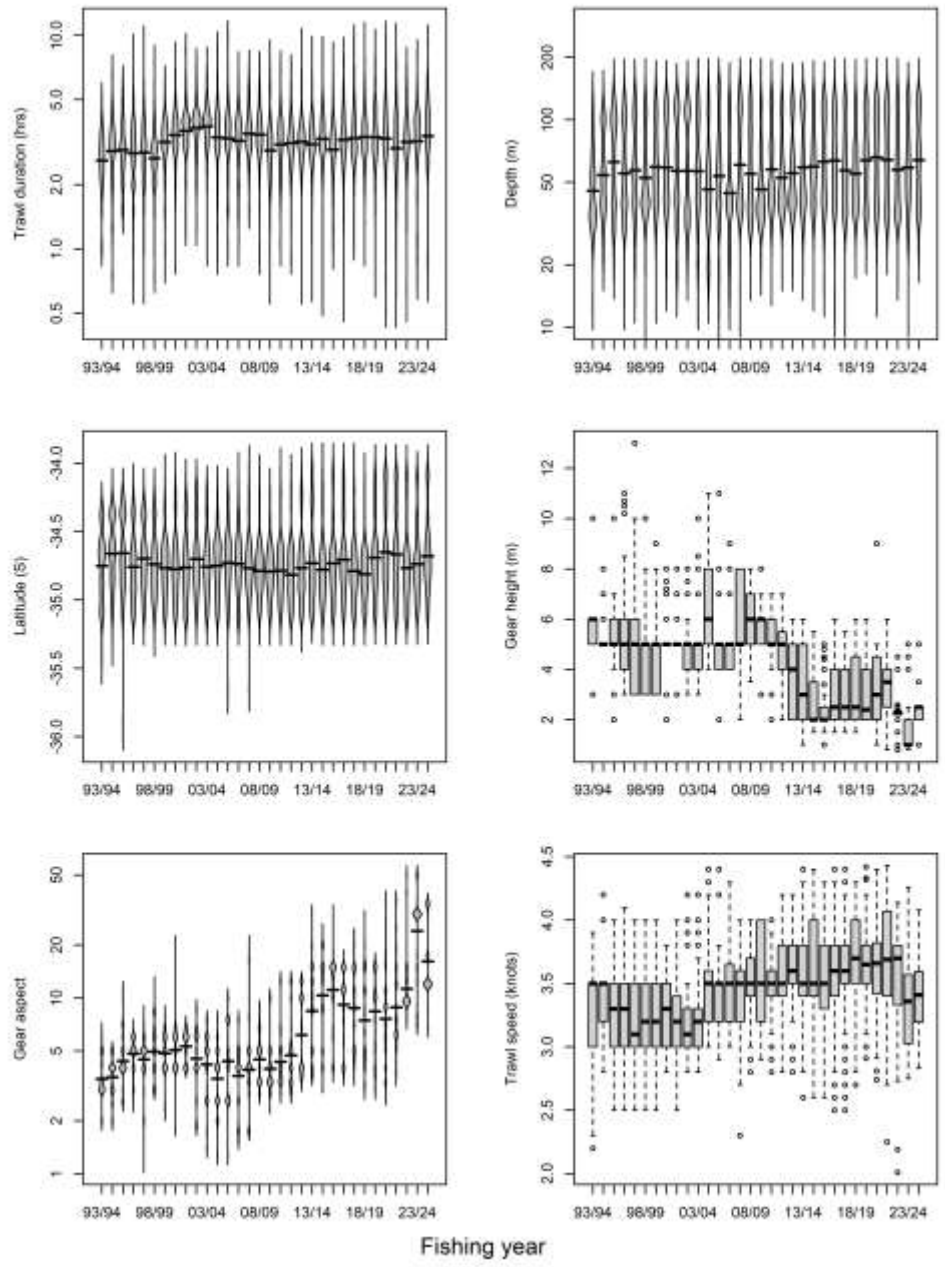


Figure A3: A summary of the fishing event data included in the NMB Trawl CPUE data set.

Table A2: Summary of stepwise selection of variables in the NMB 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			24 684		
FishingYear	31	1 176	23 508	0.048	
Speed	3	3 497	20 011	0.189	14.2%
Depth	3	1 098	18 912	0.234	4.5%
Vessel	17	616	18 296	0.259	2.5%
Month	11	615	17 681	0.284	2.5%
StartTime	3	173	17 508	0.291	0.7%
Duration	3	125	17 383	0.296	0.5%

Table A3: Summary of stepwise selection of variables in the NMB 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			15 276		
FishingYear	31	890	14 386	0.058	
Depth	3	2 871	11 515	0.246	18.8%
StartTime	3	402	11 113	0.273	2.6%
Vessel	17	375	10 738	0.297	2.5%
Speed	3	160	10 578	0.308	1.0%
Month	11	128	10 450	0.316	0.8%

Table A4: NMB 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
1993–94	0.6233	0.3718	0.9712	0.6160	0.4464	0.7660	1.0000	0.6550	1.5249
1994–95	0.8963	0.5593	1.3550	0.8450	0.7460	0.9142	1.0603	0.6791	1.5664
1995–96	0.2243	0.1191	0.3665	0.5531	0.4091	0.6982	0.4061	0.2356	0.6517
1996–97	0.5251	0.3185	0.8136	0.6896	0.5587	0.7993	0.7613	0.4898	1.1122
1997–98	0.5468	0.3479	0.7990	0.7927	0.6952	0.8716	0.6894	0.4439	1.0008
1998–99	0.3609	0.2330	0.5332	0.7360	0.6193	0.8313	0.4906	0.3157	0.7197
1999–00	0.3379	0.2214	0.5167	0.7829	0.6775	0.8646	0.4317	0.2845	0.6426
2000–01	0.2634	0.1600	0.4050	0.6624	0.5300	0.7774	0.3976	0.2524	0.5859
2001–02	0.2520	0.1506	0.3979	0.6735	0.5372	0.7947	0.3743	0.2276	0.5739
2002–03	0.1769	0.0991	0.2857	0.5928	0.4432	0.7246	0.2988	0.1787	0.4656
2003–04	0.3807	0.2328	0.5587	0.7900	0.6910	0.8717	0.4820	0.3028	0.7064
2004–05	0.5976	0.3652	0.9396	0.7552	0.6348	0.8488	0.7911	0.5106	1.2167
2005–06	0.5789	0.3298	0.9037	0.7399	0.6060	0.8427	0.7823	0.4676	1.1912
2006–07	0.4082	0.2485	0.6300	0.8869	0.8105	0.9404	0.4602	0.2849	0.6987
2007–08	0.6245	0.3797	0.9653	0.7855	0.6545	0.8768	0.7952	0.4916	1.2119
2008–09	0.4906	0.3174	0.7535	0.8471	0.7602	0.9129	0.5793	0.3784	0.8722
2009–10	0.6022	0.3729	0.9002	0.8988	0.8281	0.9478	0.6700	0.4157	1.0196
2010–11	0.6020	0.3816	0.9192	0.8897	0.8162	0.9401	0.6767	0.4311	1.0241
2011–12	0.8398	0.5376	1.2618	0.9640	0.9348	0.9820	0.8712	0.5568	1.3051
2012–13	0.7646	0.4769	1.1829	0.9394	0.8938	0.9710	0.8137	0.5068	1.2731
2013–14	0.4939	0.2974	0.7741	0.9115	0.8465	0.9525	0.5418	0.3302	0.8519
2014–15	0.6623	0.4060	1.0079	0.9311	0.8770	0.9631	0.7114	0.4399	1.0851
2015–16	0.6202	0.3831	0.9327	0.9550	0.9179	0.9768	0.6494	0.3980	0.9679
2016–17	0.4337	0.2710	0.6828	0.8929	0.8237	0.9418	0.4858	0.3070	0.7567
2017–18	0.3903	0.2446	0.5919	0.9506	0.9124	0.9750	0.4106	0.2579	0.6193
2018–19	0.3710	0.2358	0.5684	0.9663	0.9372	0.9845	0.3840	0.2434	0.5956
2019–20	0.4805	0.2962	0.7317	0.9540	0.9151	0.9771	0.5037	0.3121	0.7603
2020–21	0.6222	0.3915	0.9675	0.9709	0.9474	0.9863	0.6409	0.4028	0.9890
2021–22	0.6438	0.3959	1.0156	0.9824	0.9683	0.9913	0.6553	0.4071	1.0348
2022–23	0.5806	0.3504	0.8913	0.9508	0.9096	0.9764	0.6108	0.3696	0.9420
2023–24	0.7741	0.4529	1.2156	0.9671	0.9346	0.9860	0.8003	0.4667	1.2580
2024–25	0.6004	0.3426	0.9632	0.9575	0.9207	0.9805	0.6270	0.3610	0.9922

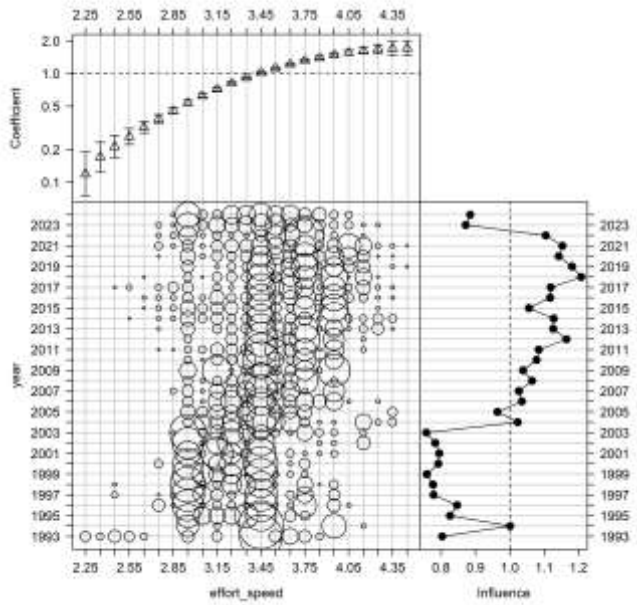


Figure A4: Influence plot of the Speed variable in the NMB Trawl positive catch CPUE model.

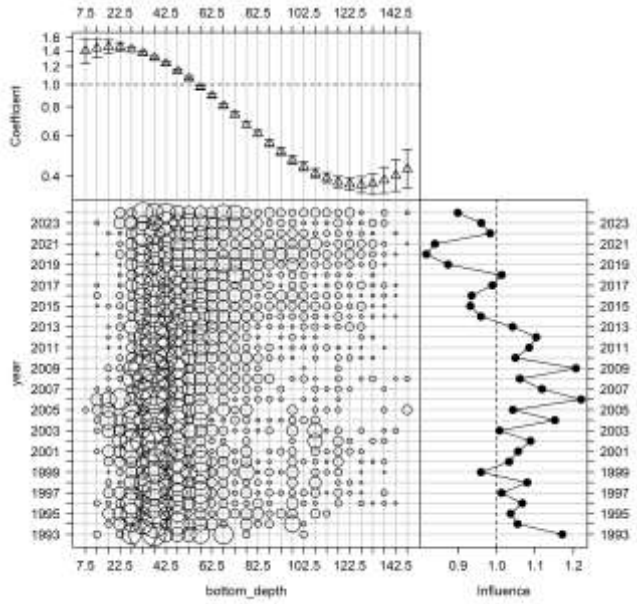


Figure A5: Influence plot of the Depth variable in the NMB Trawl positive catch CPUE model.

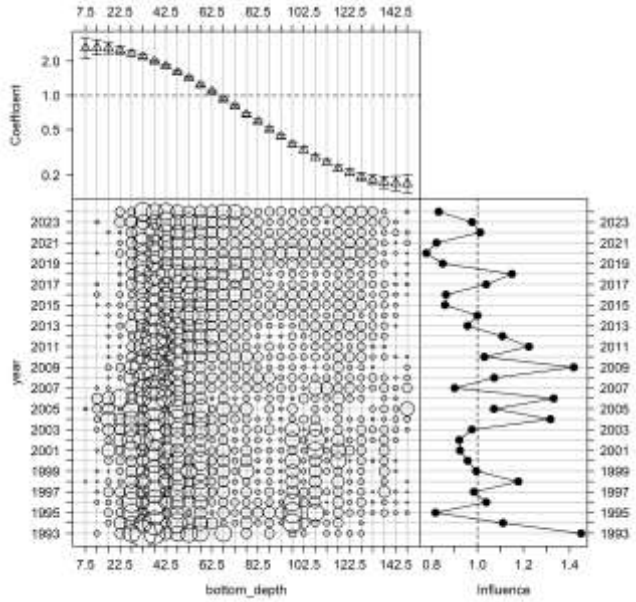


Figure A6: Influence plot of the Depth variable in the NMB Trawl occurrence CPUE model.

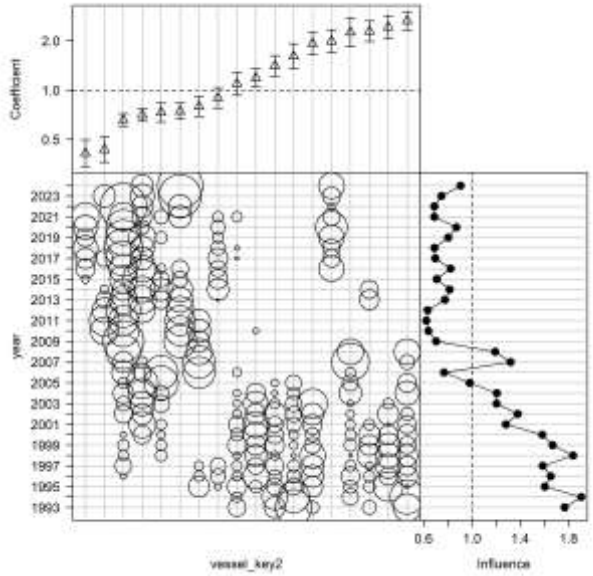


Figure A7: Influence plot of the Vessel variable in the NMB Trawl occurrence CPUE model.

APPENDIX 2: CPUE ANALYSIS - KAIPARA-MANUKAU-NORTH TARANAKI BIGHT

Table A5: Summary of the Kaipara-Manukau-North Taranaki Bight (KMNTB) 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	441	6	44	204.6	441	1 152	42.9
1994–95	499	4	42	378.1	499	1 459	34.3
1995–96	356	9	64	54.7	356	1 109	59.8
1996–97	969	10	120	293.0	969	2 698	37.7
1997–98	1 175	11	133	278.1	1 175	3 337	35.7
1998–99	870	14	112	213.6	870	2 454	34.0
1999–00	1 002	13	114	290.6	1 002	3 172	25.3
2000–01	1 020	13	130	352.1	1 020	3 359	27.6
2001–02	930	12	132	467.4	930	3 223	26.2
2002–03	806	10	109	438.8	806	2 754	25.4
2003–04	1 209	14	140	562.6	1 209	4 105	29.7
2004–05	873	13	112	361.3	873	3 213	31.7
2005–06	606	9	87	558.8	606	2 099	22.3
2006–07	916	7	99	594.7	916	2 864	13.5
2007–08	936	6	88	634.1	936	3 094	17.5
2008–09	826	6	92	579.9	826	2 919	15.0
2009–10	641	5	86	566.6	641	2 098	26.8
2010–11	760	6	106	591.7	760	2 394	20.8
2011–12	965	9	143	750.9	965	3 022	14.8
2012–13	1 220	8	148	823.8	1 220	3 914	16.4
2013–14	826	9	135	456.0	826	3 034	21.5
2014–15	944	9	132	722.0	944	3 261	19.5
2015–16	1 048	8	139	610.9	1 048	3 669	17.1
2016–17	860	9	131	513.2	860	3 042	20.2
2017–18	838	9	121	524.5	838	2 796	18.6
2018–19	543	9	102	360.6	543	1 905	23.9
2019–20	732	8	119	596.1	732	2 631	19.1
2020–21	802	7	118	401.2	802	2 685	18.1
2021–22	1 077	10	130	591.6	1 077	3 499	13.5
2022–23	631	8	94	277.1	631	2 084	16.5
2023–24	635	7	97	211.9	635	2 511	18.7
2024–25	1 102	8	143	294.3	1 102	4 540	26.7

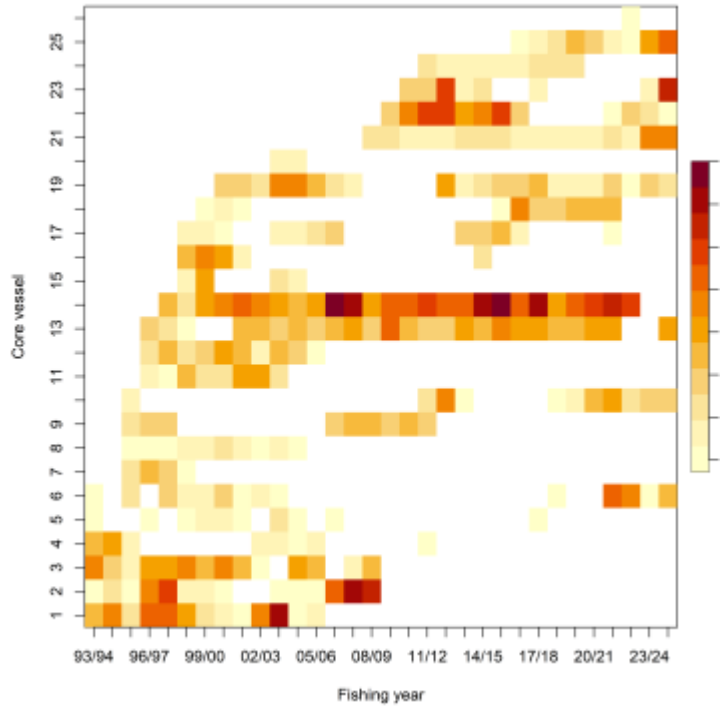


Figure A8: Annual number of trawl event records for each vessel included in the KMNTB Trawl core fleet. The colour of the cell represents the number of records from low (pale yellow) to high (dark red).

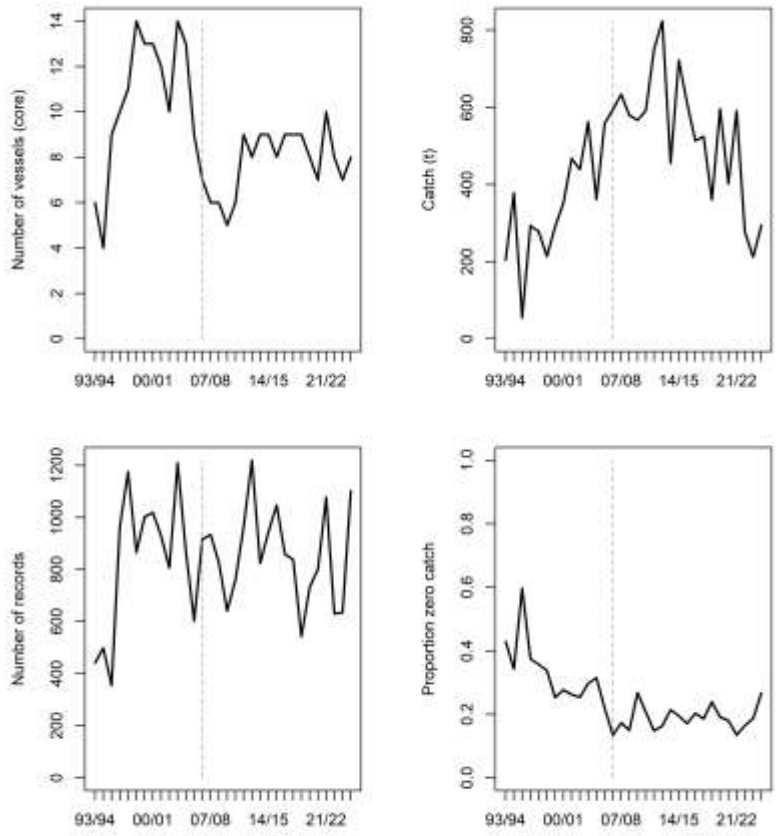


Figure A9: A summary of the data included in the KMNTB Trawl CPUE data set.

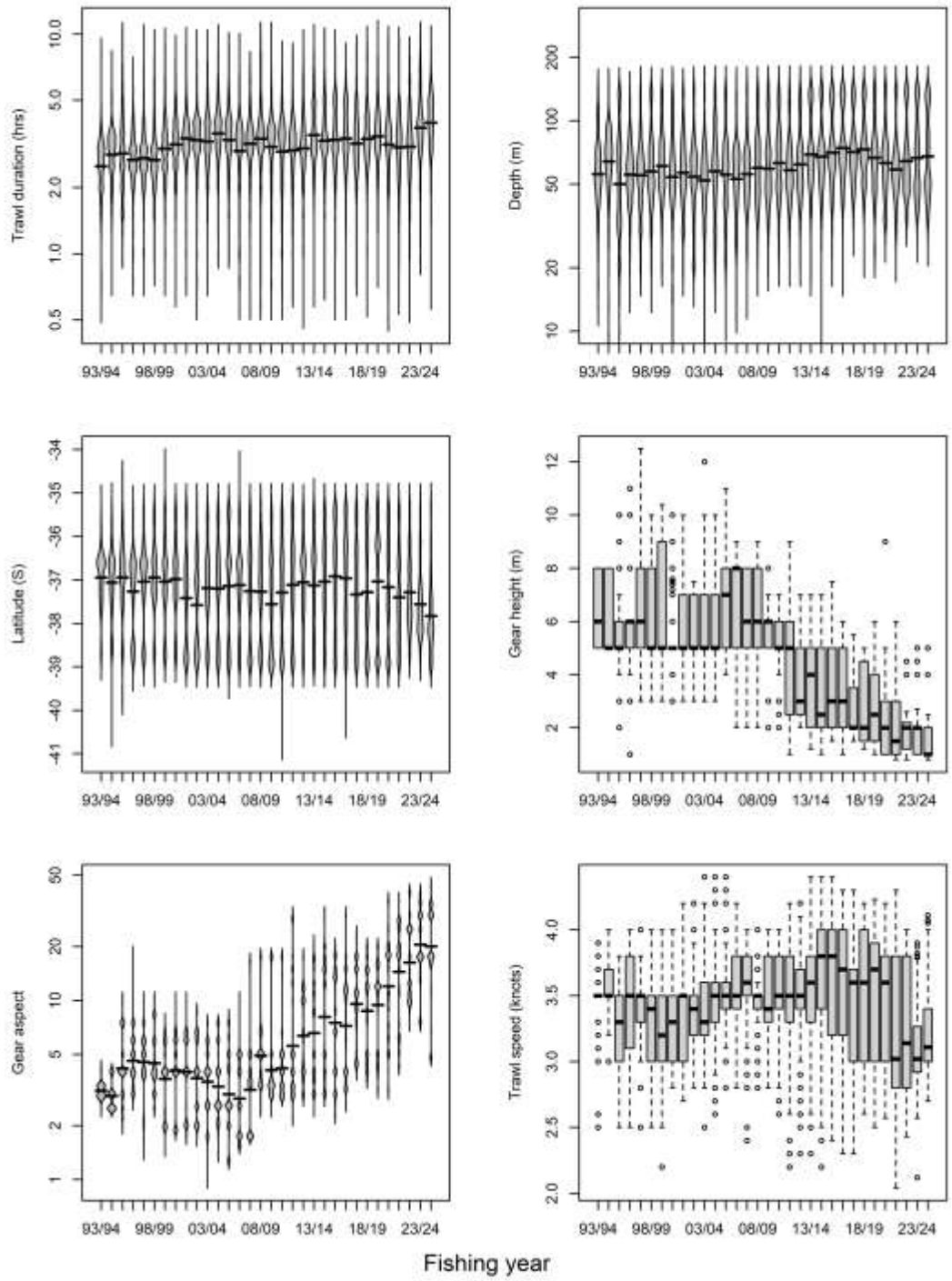


Figure A10: A summary of the fishing event data included in the KMNTB Trawl CPUE data set.

Table A6: Summary of stepwise selection of variables in the KMNTB 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			76 917		
FishingYear	31	3 662	73 254	0.048	
Speed	3	20 355	52 900	0.312	26.5%
Vessel	25	5 959	46 941	0.390	7.7%
Depth	3	3 687	43 254	0.438	4.8%
Month	6	2 837	40 417	0.475	3.7%
Duration	3	825	39 593	0.485	1.1%
Latitude	3	401	39 192	0.490	0.5%

Table A7: Summary of stepwise selection of variables in the KMNTB 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			29 647		
FishingYear	31	1 003	28 644	0.034	
Depth	3	4 625	24 019	0.190	15.6%
Speed	3	1 143	22 876	0.228	3.9%
Month	6	685	22 191	0.251	2.3%
Vessel	25	537	21 654	0.270	1.8%
StartTime	3	345	21 309	0.281	1.2%
Latitude	3	244	21 065	0.289	0.8%

Table A8: KMNTB 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
1993–94	0.5740	0.4437	0.7403	0.5710	0.4987	0.6412	1.0000	0.8113	1.2436
1994–95	0.9290	0.7135	1.1703	0.6094	0.5433	0.6786	1.5251	1.2098	1.9031
1995–96	0.3049	0.2050	0.4288	0.3868	0.3125	0.4693	0.7883	0.5745	1.0466
1996–97	0.5588	0.4416	0.7134	0.5996	0.5357	0.6618	0.9323	0.7459	1.1488
1997–98	0.5051	0.3993	0.6276	0.6356	0.5711	0.6930	0.7946	0.6413	0.9698
1998–99	0.7626	0.6030	0.9476	0.7128	0.6520	0.7708	1.0701	0.8563	1.3095
1999–00	1.1835	0.9312	1.4726	0.8440	0.8036	0.8802	1.4021	1.1116	1.7330
2000–01	1.1575	0.9253	1.4447	0.7996	0.7511	0.8425	1.4477	1.1575	1.8005
2001–02	1.1131	0.8756	1.4091	0.8057	0.7583	0.8487	1.3816	1.0952	1.7416
2002–03	1.2691	0.9978	1.5504	0.8038	0.7496	0.8474	1.5788	1.2592	1.9164
2003–04	1.0501	0.8346	1.2888	0.7498	0.6991	0.7971	1.4001	1.1433	1.7038
2004–05	0.9799	0.7733	1.2091	0.7750	0.7231	0.8256	1.2646	1.0035	1.5449
2005–06	1.4448	1.1299	1.8073	0.8380	0.7911	0.8768	1.7242	1.3556	2.1560
2006–07	1.0048	0.8141	1.2334	0.8229	0.7736	0.8640	1.2210	0.9975	1.5080
2007–08	1.1351	0.9019	1.4095	0.8157	0.7670	0.8610	1.3918	1.1179	1.7311
2008–09	1.3491	1.0671	1.6864	0.8933	0.8574	0.9226	1.5102	1.1959	1.8901
2009–10	0.9382	0.7409	1.1880	0.7916	0.7342	0.8434	1.1851	0.9399	1.4723
2010–11	1.6221	1.2804	2.0151	0.8736	0.8331	0.9062	1.8570	1.4752	2.3125
2011–12	1.5609	1.2330	1.9570	0.9225	0.8935	0.9452	1.6920	1.3296	2.1105
2012–13	1.4164	1.1308	1.7725	0.9289	0.9039	0.9495	1.5247	1.2161	1.8970
2013–14	0.9152	0.7194	1.1567	0.9408	0.9178	0.9588	0.9728	0.7647	1.2317
2014–15	0.9722	0.7593	1.2253	0.9187	0.8878	0.9425	1.0581	0.8318	1.3359
2015–16	0.7619	0.6027	0.9505	0.9598	0.9440	0.9719	0.7938	0.6277	0.9939
2016–17	0.8508	0.6641	1.0690	0.9594	0.9443	0.9713	0.8869	0.6935	1.1145
2017–18	0.8365	0.6556	1.0676	0.9653	0.9508	0.9769	0.8665	0.6795	1.1025
2018–19	0.9854	0.7596	1.2455	0.9495	0.9258	0.9659	1.0378	0.8003	1.3129
2019–20	0.9951	0.7868	1.2478	0.9315	0.9052	0.9526	1.0684	0.8464	1.3515
2020–21	0.7300	0.5657	0.9336	0.9486	0.9272	0.9658	0.7696	0.5931	0.9827
2021–22	1.0094	0.7967	1.2606	0.9697	0.9561	0.9795	1.0409	0.8214	1.2939
2022–23	1.5851	1.2198	2.0005	0.9698	0.9563	0.9805	1.6345	1.2556	2.0610
2023–24	1.5188	1.1604	1.9763	0.9754	0.9627	0.9845	1.5570	1.1912	2.0144
2024–25	1.0489	0.8038	1.3257	0.9650	0.9512	0.9771	1.0869	0.8360	1.3763

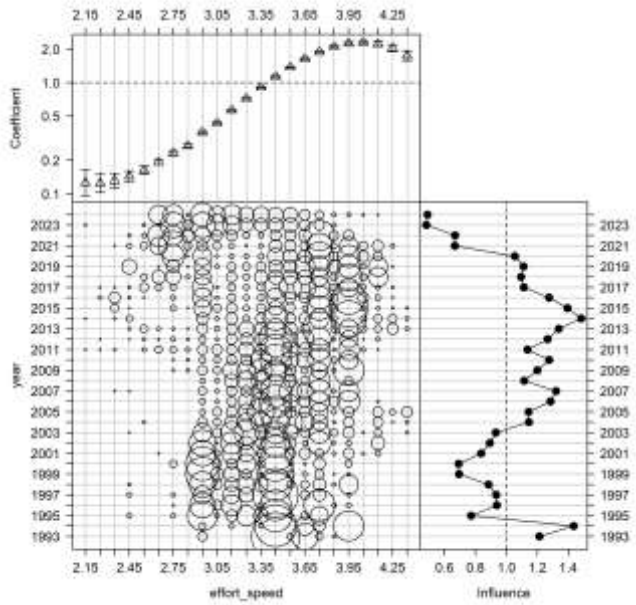


Figure A11: Influence plot of the Speed variable in the KMNTB Trawl positive catch CPUE model.

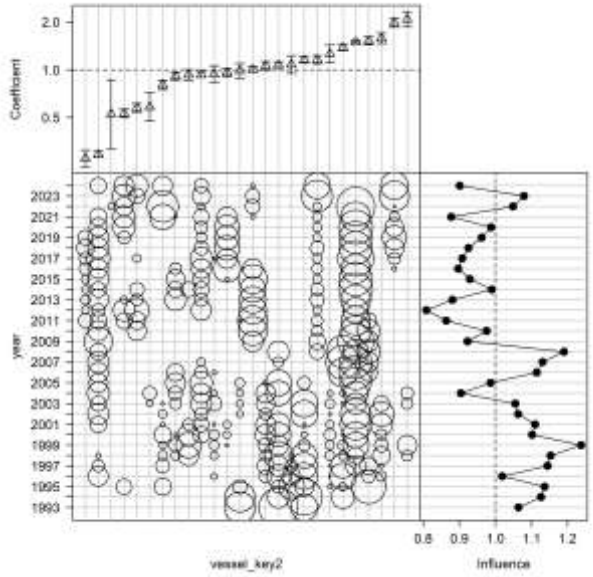


Figure A12: Influence plot of the Vessel variable in the KMNTB Trawl positive catch CPUE model.

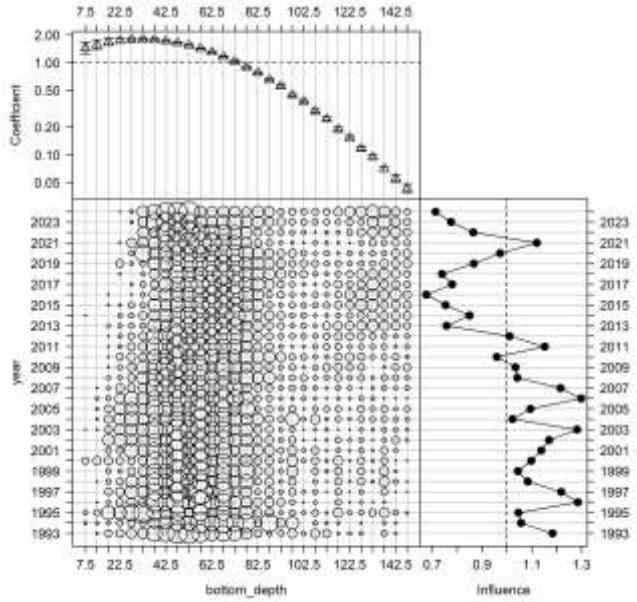


Figure A13: Influence plot of the Depth variable in the KMNTB Trawl occurrence CPUE model.

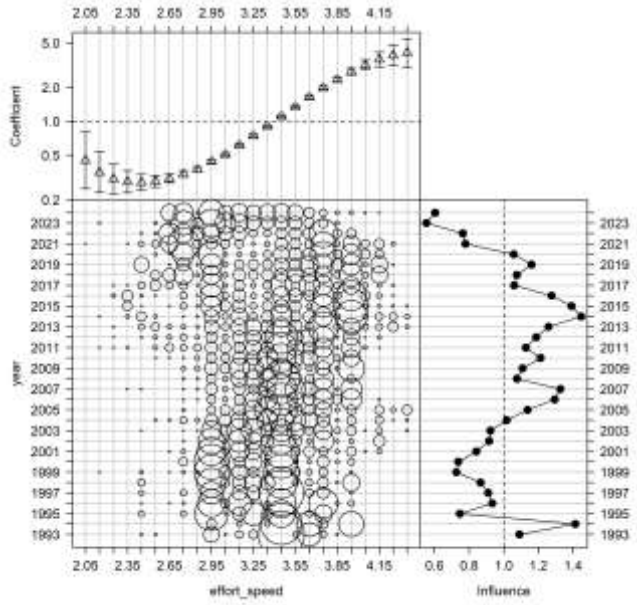


Figure A14: Influence plot of the Speed variable in the KMNTB Trawl occurrence CPUE model.

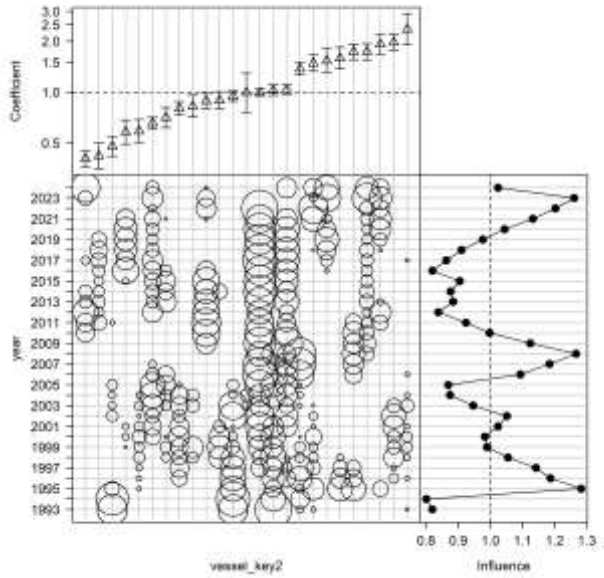


Figure A15: Influence plot of the Vessel variable in the KMNTB Trawl occurrence CPUE model.

APPENDIX 3: CPUE ANALYSIS - SOUTH TARANAKI BIGHT

Table A9: Summary of the South Taranaki Bight (STB) event-based 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	612	11	127	33.0	612	2 362	51.5
2008–09	541	11	140	59.5	541	2 153	50.1
2009–10	599	10	144	68.6	599	2 206	52.3
2010–11	876	12	160	171.4	876	2 980	52.6
2011–12	915	13	171	84.3	915	3 416	59.7
2012–13	870	12	174	130.1	870	3 206	44.7
2013–14	745	12	156	64.0	745	2 706	51.0
2014–15	665	12	136	25.3	665	2 439	58.2
2015–16	686	12	126	82.2	686	2 499	56.6
2016–17	612	11	140	80.4	612	2 164	48.0
2017–18	635	9	128	82.0	635	2 433	48.3
2018–19	675	10	115	50.1	675	2 458	47.4
2019–20	560	10	105	36.3	560	2 057	53.4
2020–21	657	9	124	24.9	657	2 530	59.7
2021–22	531	10	101	33.7	531	1 988	50.3
2022–23	585	8	90	51.2	585	2 214	56.8
2023–24	365	7	65	16.4	365	1 396	50.7
2024–25	547	8	99	12.5	547	2 183	54.7

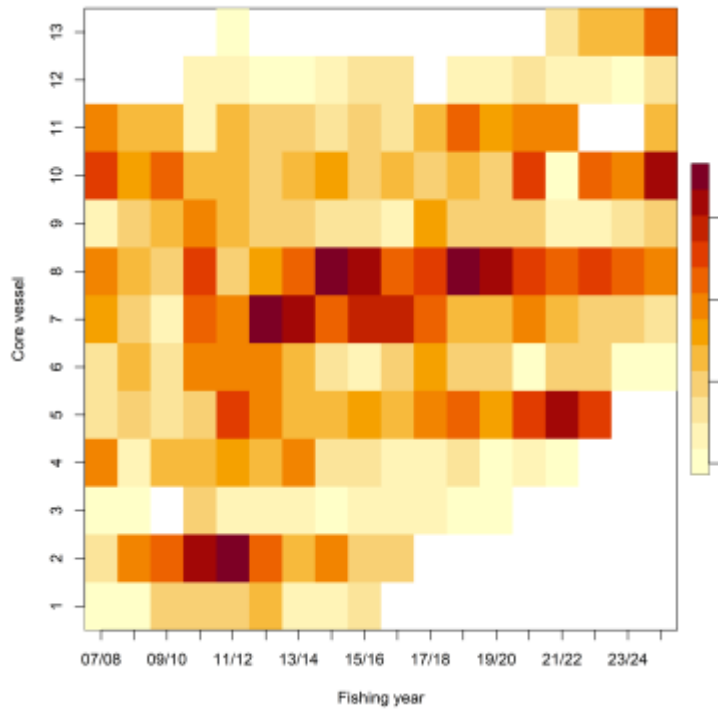


Figure A16: Annual number of trawl event records for each vessel included in the STB Trawl core fleet. The colour of the cell represents the number of records from low (pale yellow) to high (dark red).

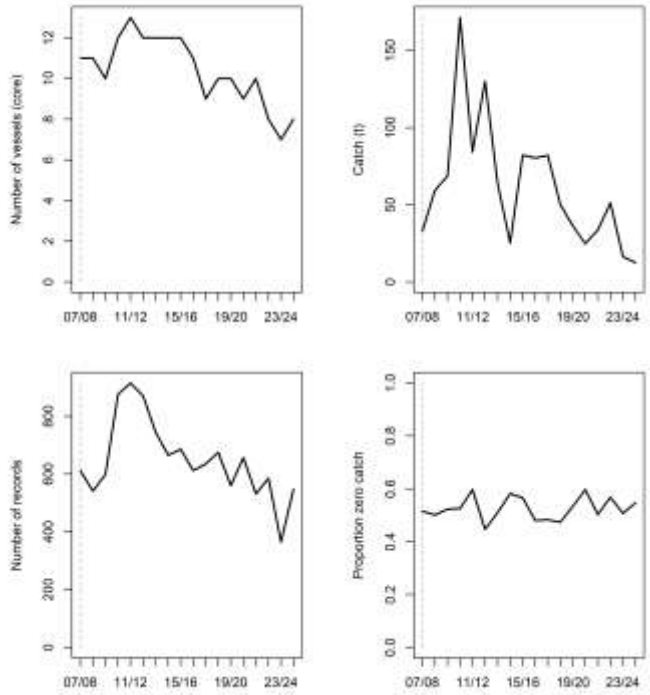


Figure A17: A summary of the data included in the STB Trawl CPUE data set.

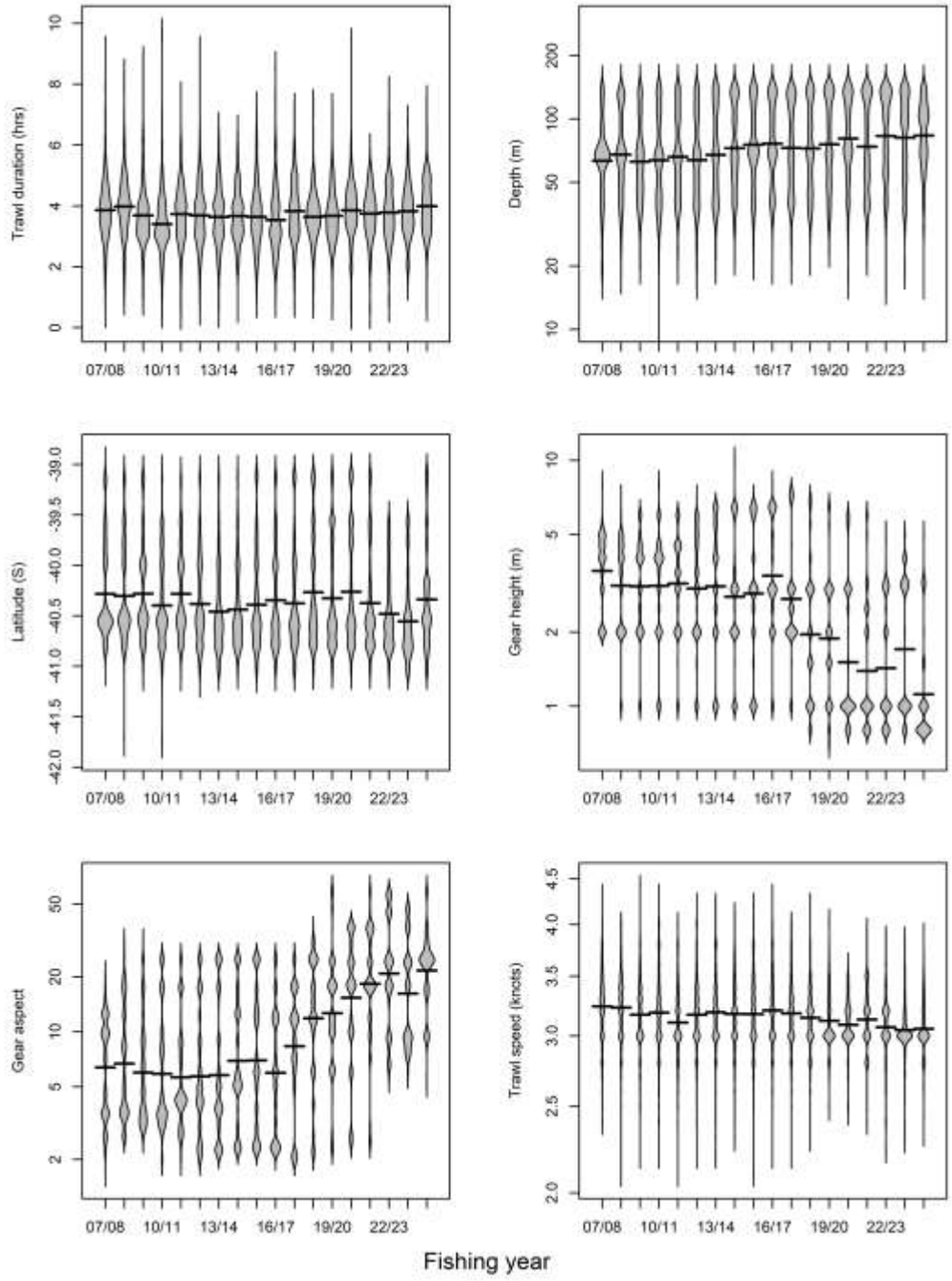


Figure A18: A summary of the fishing event data included in the STB Trawl CPUE data set.

Table A10: Summary of stepwise selection of variables in the STB 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			32 656		
FishingYear	17	714	31 943	0.022	
Duration	3	1 062	30 881	0.054	3.3%
SubArea	3	9 027	21 854	0.331	27.6%
Vessel	12	2 509	19 345	0.408	7.7%
Depth	3	1 078	18 267	0.441	3.3%
Speed	3	888	17 379	0.468	2.7%
EffortHeight	3	501	16 878	0.483	1.5%

Table A11: Summary of stepwise selection of variables in the STB 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			16 022		
FishingYear	17	89	15 933	0.006	
SubArea	3	2 073	13 860	0.135	12.9%
Depth	3	466	13 394	0.164	2.9%
Vessel	12	153	13 241	0.174	1.0%
Month	11	141	13 099	0.182	0.9%
Speed	3	101	12 998	0.189	0.6%

Table A12: STB 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
2007–08	0.4994	0.3564	0.6774	0.4910	0.4264	0.5584	1.0000	0.7469	1.3628
2008–09	1.2733	0.9293	1.6889	0.4783	0.4109	0.5483	2.6619	1.9740	3.4677
2009–10	0.9915	0.7045	1.3407	0.4043	0.3450	0.4721	2.4521	1.8313	3.1739
2010–11	0.4665	0.3435	0.6269	0.4016	0.3439	0.4636	1.1619	0.8984	1.4993
2011–12	0.5372	0.3845	0.7218	0.3491	0.2979	0.4091	1.5386	1.1709	2.0033
2012–13	1.0375	0.7715	1.3523	0.4974	0.4351	0.5585	2.0863	1.5954	2.6626
2013–14	0.6559	0.4845	0.8657	0.4621	0.3990	0.5271	1.4196	1.0703	1.8381
2014–15	0.6422	0.4514	0.8737	0.4126	0.3493	0.4777	1.5569	1.1395	2.0489
2015–16	0.8642	0.6036	1.1501	0.4404	0.3717	0.5044	1.9624	1.4717	2.5643
2016–17	1.1814	0.8714	1.5886	0.5700	0.5031	0.6349	2.0727	1.5368	2.7519
2017–18	1.0745	0.7699	1.4501	0.5430	0.4729	0.6112	1.9784	1.4601	2.6221
2018–19	1.4268	1.0498	1.9313	0.5877	0.5222	0.6538	2.4273	1.8486	3.2313
2019–20	1.0135	0.7344	1.3743	0.5572	0.4907	0.6287	1.8194	1.3628	2.4013
2020–21	1.3790	0.9700	1.8982	0.5231	0.4482	0.5909	2.6352	1.9574	3.4854
2021–22	2.2762	1.5697	3.1576	0.6011	0.5265	0.6720	3.7873	2.6719	5.0986
2022–23	4.6606	3.2607	6.3917	0.6383	0.5681	0.7056	7.3038	5.1288	9.9394
2023–24	3.1999	2.2514	4.4700	0.6771	0.6029	0.7407	4.7266	3.3143	6.6118
2024–25	3.1830	2.2608	4.3298	0.7188	0.6542	0.7785	4.4303	3.1817	5.9462

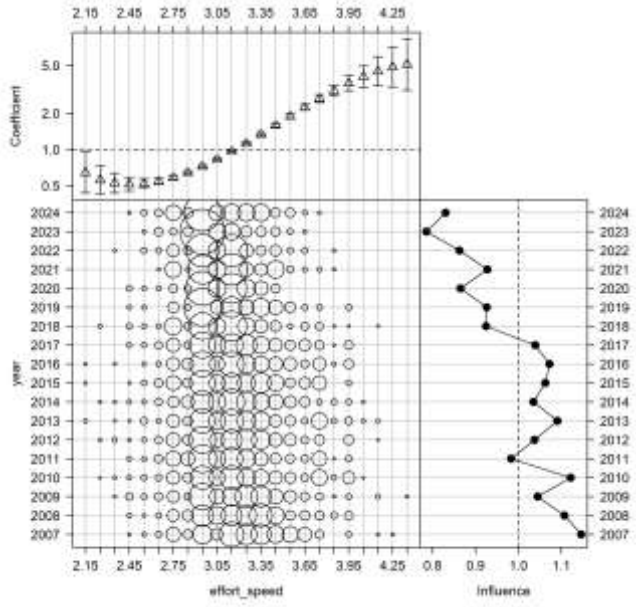


Figure A19: Influence plot of the Speed variable in the STB Trawl positive catch CPUE model.

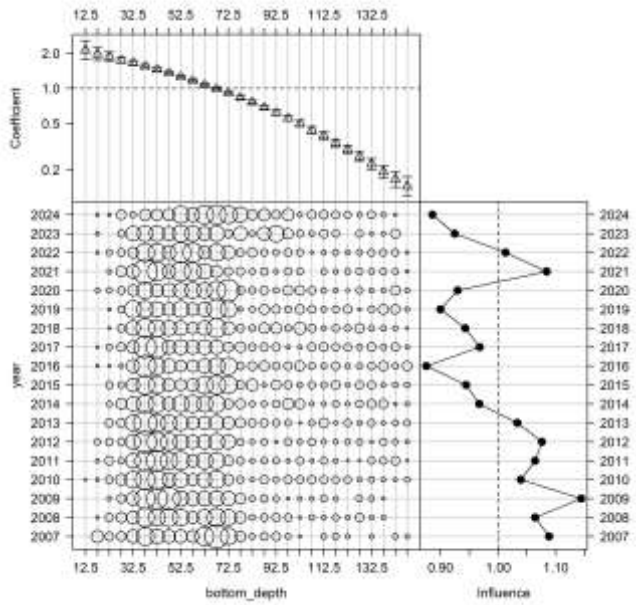


Figure A20: Influence plot of the Depth variable in the STB Trawl positive catch CPUE model.

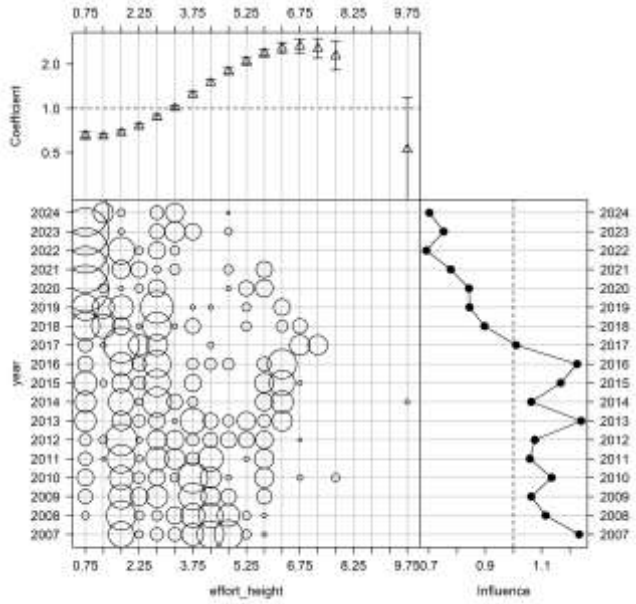


Figure A21: Influence plot of the GearHeight variable in the STB Trawl positive catch CPUE model.

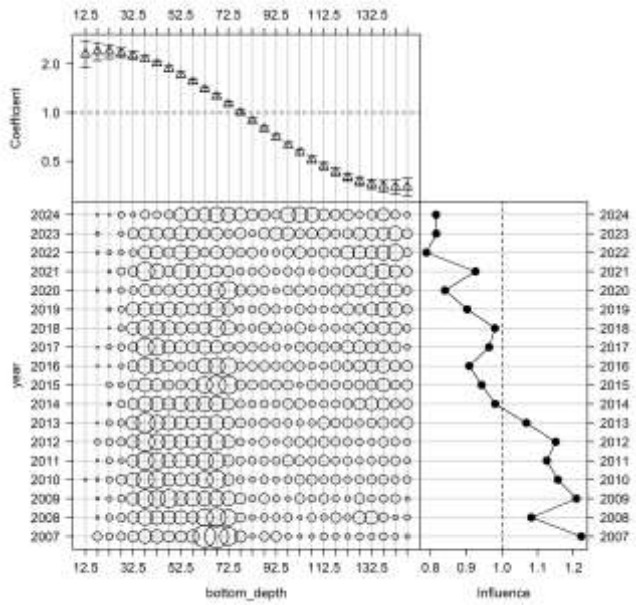


Figure A22: Influence plot of the Depth variable in the STB Trawl occurrence CPUE model.

APPENDIX 4: ASSESSMENT MODEL CATCH HISTORY

Table A13: Catch history for the commercial fisheries (including unreported catches) included in the assessment models.

Sub-area Gear	NMB BT	KMNTB BT	NMB and KMNTB BPT	STB BT and BPT
1975	0	0	1 464	551
1976	0	0	1 728	665
1977	0	0	2 048	564
1978	0	0	2 144	711
1979	12	39	2 542	597
1980	130	422	1 930	573
1981	202	660	2 012	673
1982	73	237	2 291	457
1983	64	165	1 828	542
1984	56	146	1 418	427
1985	66	171	1 514	461
1986	82	213	1 299	420
1987	197	778	441	373
1988	211	831	470	398
1989	198	782	443	375
1990	114	667	452	468
1991	17	680	499	941
1992	77	788	260	309
1993	364	1 073	193	238
1994	440	1 049	515	294
1995	561	1 045	210	365
1996	345	767	512	416
1997	549	858	56	399
1998	355	1 204	33	531
1999	259	1 210	268	433
2000	298	954	338	687
2001	140	896	445	425
2002	77	962	279	510
2003	221	1 162	442	246
2004	204	1 162	467	345
2005	268	916	551	229
2006	118	1 200	362	296
2007	189	1 271	110	186
2008	160	1 213	327	114
2009	324	1 223	306	185
2010	473	951	322	240
2011	311	959	360	311
2012	413	1 297	0	204
2013	209	1 443	0	208
2014	483	887	0	256
2015	551	1 211	0	79
2016	639	1 060	0	270
2017	601	796	0	348
2018	641	964	0	180
2019	350	912	0	178
2020	278	1 028	0	300
2021	386	663	0	109
2022	414	960	0	102
2023	312	620	0	211
2024	211	435	0	234
2025	302	682	0	342