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Descriptive analysis of ling off the west coast South Island (LIN 7WC) up to 2025 and inputs for the 2026 stock assessment

New Zealand Fisheries Assessment Report 2026/25

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ISSN 1179-5352 (online)
ISBN 978-1-997337-45-4 (online)

July 2026

Te Kāwanatanga o Aotearoa
New Zealand Government

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Please cite this report as:

Mormede, S.; Dunn, A.; Webber, D.N. (2026). Descriptive analysis of ling off the west coast South Island (LIN 7WC) up to 2025 and inputs for the 2026 stock assessment. *New Zealand Fisheries Assessment Report 2026/25.* 82 p.

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PLAIN LANGUAGE SUMMARY

Ling (*Genypterus blacodes*) is an important commercial fish species in New Zealand middle depths waters and is caught mainly by bottom trawls, bottom longlines, and increasingly by potting.

This report summarises the characterisation of one of the five main ling stocks managed under the Quota Management System: the ling stock off the west coast of the South Island (LIN 7WC), up to and including December 2025.

Both the ling Total Allowable Commercial Catch (TACC) and catches have been stable in most Quota Management Areas (QMAs) recently. Recent catches of ling in LIN 7 were close to the TACC.

Biological relationships were updated using the latest data available. Maturity has been variable in recent years.

The standardised catch per unit effort (CPUE) indices and the trawl survey biomass index all showed similar patterns from 2000, with a continued decline from 2012.

EXECUTIVE SUMMARY

Mormede, S.[1]; Dunn, A.[2]; Webber, D.N.[3] (2026). Descriptive analysis of ling off the west coast South Island (LIN 7WC) up to 2025 and inputs for the 2026 stock assessment

New Zealand Fisheries Assessment Report **2026/25. 82 p.**

Ling (*Genypterus blacodes*) are an important commercial species caught mainly by bottom trawls and bottom longlines and since 2020 by potting; they are found throughout the middle depths of New Zealand waters. High catches of ling were recorded in the late 1970s before dropping in the early 1980s and increasing again to a series high in the mid-1990s followed by lower and variable levels of catch since. Ling are managed as eight administrative Quota Management Areas (QMAs) with five of those reporting about 95% of the landings. There are at least four major biological stocks: the Chatham Rise, the Sub-Antarctic (including the Stewart-Snares shelf and Puysegur Bank and the Bounty Platform), the west coast of the South Island, and Cook Strait.

This report summarises a characterisation of the ling stock off the west coast of the South Island (LIN 7WC) and fishery up to the 2024–25 fishing year. It provides an updated characterisation of the stock, revised catch per unit effort (CPUE) indices for the bottom longline and bottom trawl fisheries, and a summary of the input parameters for the 2026 stock assessment of LIN 7WC.

Both the ling Total Allowable Commercial Catch (TACC) and catches have been stable in most QMAs recently. Recent catches of ling in LIN 7 (the west coast of the South Island and the western part of the Cook Strait) are close to the TACC. In 2023, for stock assessment purposes Statistical Area 032 was reassigned from the Sub-Antarctic stock (LIN 5&6) to the west coast of the South Island stock (LIN 7WC) based on the continuity of catch locations.

The length-weight relationship for ling in LIN 7WC was updated with the latest available data. The growth function was also updated, including using Bayesian inference, and the Bayesian von Bertalanffy growth estimates were used for the stock assessment.

The rolled-up longline standardised CPUE and commercial trawl standardised CPUE for ling in LIN 7WC and the trawl survey biomass index all showed similar patterns from 2000, with a decline from 2012. The trawl CPUE was higher than the longline CPUE prior to 2000. Both the longline and trawl CPUE indices, and the trawl survey biomass indices, were considered in the stock assessment.

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1. INTRODUCTION

Ling (*Genypterus blacodes*) are an important commercial species targeted by both bottom trawls and demersal longlines, with an increasing use of pots since around 2020. Adult ling are found throughout the middle depths of the New Zealand Exclusive Economic Zone (EEZ) typically in depths of 100 m to 800 m (Hurst et al. 2000). Ling are caught mainly by deepwater trawlers, often as bycatch in hoki (*Macruronus novaezelandiae*) target fisheries, and by demersal longliners, as well as from targeted potting since 2020 (Mormede et al. 2022, 2023a, 2024a, 2024b).

Ling are managed as eight administrative Quota Management Areas (QMAs), with five (LIN 3, 4, 5, 6, and 7) reporting about 95% of landings. There are at least four major biological stocks of ling in New Zealand waters (Horn 2005; Mormede et al. 2024b; Fisheries New Zealand 2026)—the Chatham Rise, the Sub-Antarctic (including the Stewart-Snares shelf and Puysegur Bank and the Bounty Platform), the west coast of the South Island, and Cook Strait.

Stock assessments have been carried out for ling for the biological stocks of the Chatham Rise (LIN 3&4), the Sub-Antarctic (LIN5 & LIN6 including the Campbell Plateau, Stewart-Snares shelf and the Bounty Platform), the west coast South Island (LIN 7 west of Cape Farewell, labelled LIN 7WC), and Cook Strait (the part of LIN 2 and LIN 7 between latitudes 41º and 42º S and longitudes 174º and 175.4º E, labelled LIN 7CK). An administrative Fishstock (with no recorded landings) is also defined for the Kermadec Fisheries Management Area (FMA) (LIN 10) (Fisheries New Zealand 2026).

The ling biological stocks were defined using statistical areas as described in Table 1, Figure 1, and Figure 2. Starting in 2023, the LIN 7WC ling stock included Statistical Area 032, which was previously considered part of the Sub-Antarctic stock (LIN 5&6). Based on the continuity of catches of ling from LIN 7WC to Statistical Area 032, this area was included within LIN 7WC, rather than in LIN 5&6. This split was confirmed based on additional analyses including growth (Mormede et al. 2024b).

The catch and Total Allowable Commercial Catch (TACC) for ling in LIN 7 are shown in Figure 3. Note that the catch for the ling stock off the west coast of the South Island (LIN 7WC) includes part of the catch in LIN 5 (as Statistical Area 032) and excludes the part of LIN 7 which is part of the Cook Strait stock (LIN 7CK).

This report fulfils Specific Objective 1 of Project LIN2025-01. The overall Objective was "To carry out a stock assessment of ling (*Genypterus blacodes*) from the west coast of the South Island including estimating biomass and sustainable yields". The Specific Objective 1 was "To complete a descriptive analysis of the commercial catch and effort data, trawl survey data, and observer data for ling off the west coast of the South Island (LIN 7)". This report provides a descriptive summary of catch and effort data since 1989–90, a spatial temporal analysis, updated biological parameters, and an analysis of the catch per unit of effort (CPUE) data for ling off the west coast of the South Island. Fishery descriptives are given in calendar years from 1990–91 (denoted 1991) to 2024–25 (2025) whilst CPUE analyses are carried out in calendar years to match the stock assessment definition.

Table 1: Definition of the stocks for ling, noting that Southland, Sub-Antarctic and Bounty are assessed as a single stock (Mormede et al. 2024b, 2024c).

Area	Statistical Areas	Administrative	Assessment stock
Northern North Island	041–048, 001–010, 101–110, 801	LIN 1	–
East North Island	011–015, 201–206	LIN 2	–
East South Island	018–024, 301	LIN 3	LIN 3&4
Chatham Rise	049–052, 401–412	LIN 4	LIN 3&4
Southland	025–031, 302, 303, 501–504	Part of LIN 5	LIN 5&6 & LIN 6B
Sub-Antarctic	601–606, 610–612, 616–620, 623–625	Part of LIN 6	LIN 5&6 & LIN 6B
Bounty	607–609, 613–615, 621, 622	Part of LIN 6	LIN 5&6 & LIN 6B
West South Island	032–036, 701–706	Parts of LIN 7 & 5	LIN 7WC
Cook Strait	016, 017, 037–040	Parts of LIN 2 & 7	LIN 7CK

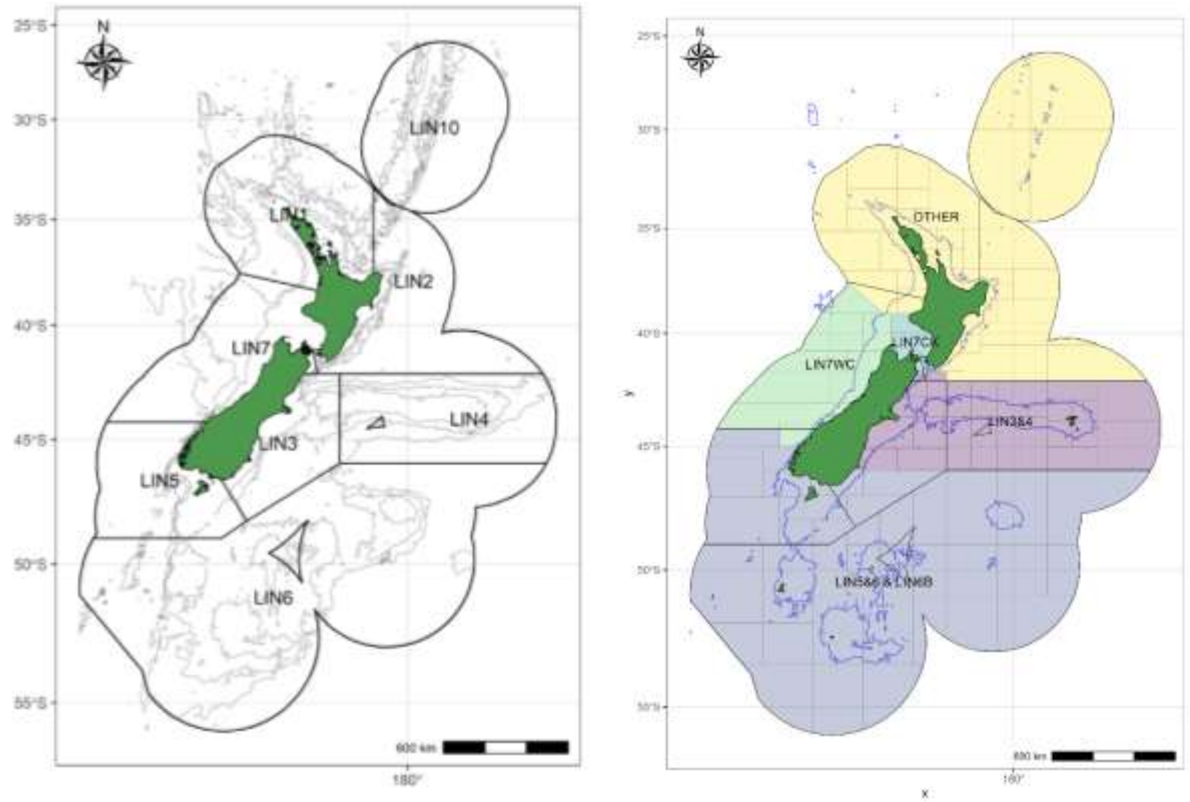


Figure 1: Quota Management Areas (QMAs, left) and biological stock boundaries (right) for ling, as used in this analysis (Mormede et al. 2024b).

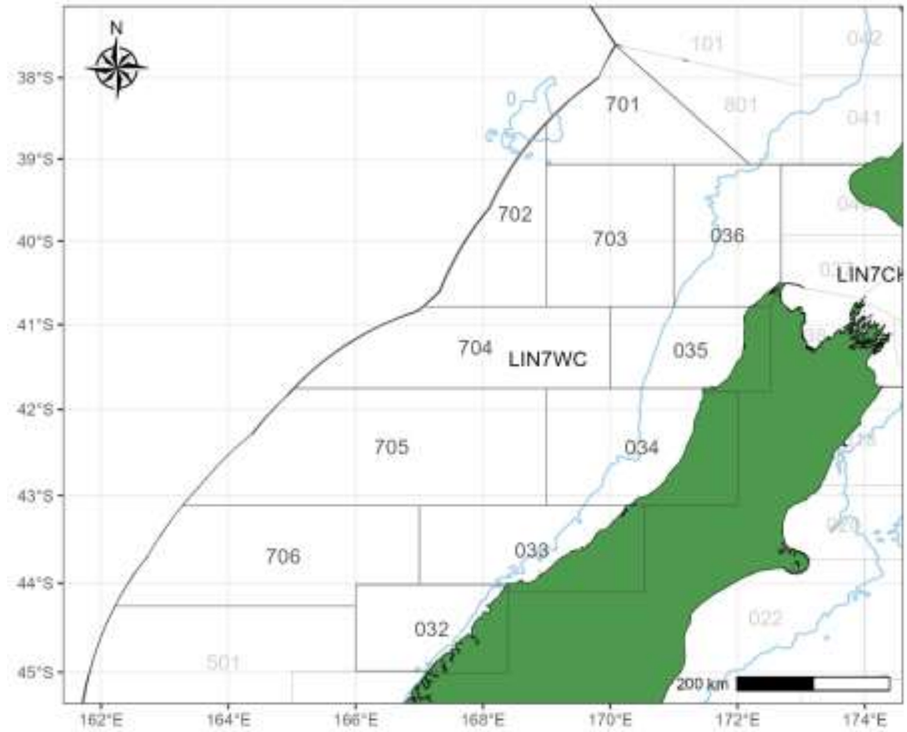


Figure 2: Statistical areas in the LIN 7WC region (labelled in black), and the surrounding statistical areas (labelled in grey).

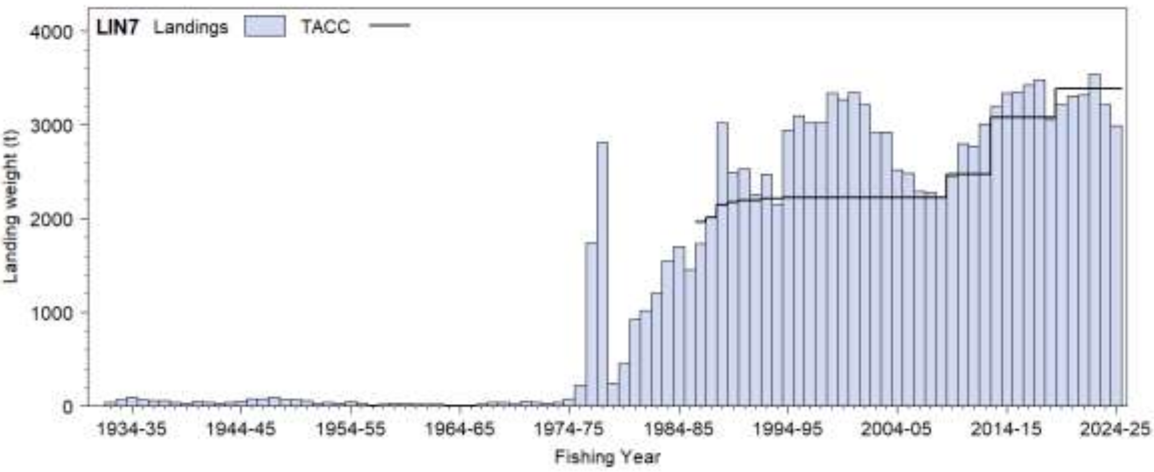


Figure 3: Annual reported catch of ling in LIN 7 (bars) and the TACC for ling (black line) for fishing years to 2024–25 (Fisheries New Zealand 2026).

2. SUMMARY OF THE LING FISHERY IN LIN 7WC

2.1 Available data

Data available for ling off the west coast of the South Island include catch and effort data, observer data from observed trips, and resource surveys.

Commercial catch and effort data were analysed to summarise and characterise the ling fishery and revise the CPUE indices for the stock. Catch and effort data and landings of ling have been misreported in the past; however, the amount of catch misreported off the west coast was low (Dunn 2003) and was therefore not included in the stock assessment.

Catch and effort data were extracted by Fisheries New Zealand for the period from 1st October 1989 to 3rd January 2026 that included all available data at the date of the extract (5th November 2025, updated 15th January 2026) (REPLOG 17046). The data extract included all data from trips where hoki, hake (*Merluccius australis*), or ling were reported as either caught, processed, or landed and all fishing recorded on trawl catch, effort and processing returns (TCEPRs); trawl catch and effort returns (TCERs); catch, effort and landing returns (CELRs); lining catch and effort returns (LCERs); lining trip catch and effort returns (LTCERs); netting catch, effort and landing returns (NCELRs); electronic reporting system returns for all methods (ERS); and any high seas reports.

Observer data for ling from the Fisheries New Zealand observer sampling programme were also extracted and included all observer trips that reported hoki, hake, or ling as of 5th November 2025 (REPLOG 17046). In addition, biological and length frequency information from these trips were also extracted, along with any otolith age readings associated with these trips. An updated extract of age data was carried out on 28th January 2026 under REPLOG 17236.

Resource survey data (including data from the RV *Tangaroa* west coast South Island standardised trawl survey and any other research voyages that reported ling) were extracted, along with any biological, length frequency information, and associated otolith age readings from these trips (REPLOG 17046).

2.2 Data checks

Catch and effort data were corrected for errors using checking and imputation algorithms similar to those reported by Mormede et al. (2024a) and implemented in the software package ‘R’ (R Core Team 2025). Individual tows were investigated, and errors were corrected using median imputation for start/finish latitude or longitude, fishing method, target species, tow speed, net depth, bottom depth, wingspread, duration, number of events, and headline height for each fishing day for a vessel. Range checks were defined for the remaining attributes to identify potential outliers in the data. The outliers were checked and corrected with median or mean imputation on larger ranges of data such as vessel, target species, and fishing method for a year or month.

Fish biological stocks and statistical areas were assigned based on the corrected positions or the reported statistical area where no specific location was available. For the purposes of this analysis tows were classified as bottom trawl (BT), midwater trawl (MW), and midwater trawl fished within 5 m of the seafloor (MB).

Non-landed destination codes and end of year codes were removed from the landings data. Because ling trips often covered multiple QMAs, the estimated catch for each record in the catch and effort data was first scaled to the landings by trip and QMA and then scaled to the Monthly Harvest Returns (MHR) by QMA prior to being used to determine the catch per year and fishery for stock assessment purposes.

2.3 Results

The TACC for ling has been stable in most QMAs since 2005; it was increased in LIN 5 in 2019 and 2023, and in LIN 7&8 in 2020 (Table A.1 of Appendix A). The highest catch of ling was caught in LIN 5, followed by LIN 6 and LIN 7, then LIN 4 and LIN 3, with little caught elsewhere. This trend has been stable over time (Table A.2 to Table A.4). Over the last few years, ling catches have been well below the TACC, apart from LIN 5 and LIN 7 where catches have been at about the TACC in recent years, and LIN 3 for the most recent years. The forms ling was reported on have changed over time: from predominantly CELR and LCER to predominantly LTCER and TCEPR in the 2000s, and then to ERS forms starting in 2018 (Table A.5).

Ling used to be caught predominantly by bottom longliners targeting ling, followed by bottom trawlers and midwater trawlers targeting either hoki or ling. Potting has become a more important method off the west coast of the South Island starting in 2021 and now represents about 23% of total annual catches in LIN7WC (Table A.6 and Figure A.1 to Figure A.3). Ling have been caught throughout the year for longliners and potting and predominantly between June and September for bottom and midwater trawls (Figure A.4). Trawl vessels are a mixture of smaller and larger vessels, whereas the most common vessel length for longliners and potting is under 28 m (Figure A.5). Ling was predominantly the top species caught by longline and potting vessels and was usually within the top three species caught by bottom trawl vessels (Figure A.6 and Figure A.7). Ling have typically been caught at bottom depths of between 250 and 750 m; the depths fished have spread slightly over time for bottom longlines but not for bottom trawls (Figure A.8).

The location of the catches differs slightly between the bottom trawl and longline fleets (Figure A.9 by statistical area, Figure A.10 and Figure A.11), with Statistical Areas 032 to 034 being predominantly fished by bottom longlines, Statistical Area 033 predominantly fished by potting and Statistical Areas 034 and 035 predominantly fished by bottom trawls. To represent the expansion or retraction of the area fished over time, the area covered by the fishing fleet targeting 90% of the ling catches was investigated at the 0.1° cell, by summarising the number of those 0.1° cells where fishing occurred based on location of fishing in any one year as well as the cumulative number of cells fished for the first time each year (Figure A.12). All fleets showed a continued increase in the number of new areas explored to date, consistent with the spatial plots (Figure A.10 and Figure A.11). The longline fleet showed a continued increase in the area fished in any year, consistent with the increase in annual total catches of ling (Table A.6), noting that only a third of longline records prior to 2008 had location information. The location of the research survey encompasses most ling catches by bottom trawl but only a small portion of the midwater trawl, bottom longline and potting catches, highlighting that the survey does not adequately cover the entire fishing grounds (Figure A.13).

The effort characteristics of the bottom trawl and longline fleets have been relatively stable over time (Figure A.14 and Figure A.15). The number of hooks reported per fishing event in LIN 7WC since 2020 has dropped dramatically (Figure A.15 and Figure A.16), with an associated increase in the number of fishing events recorded per vessel and per day (Figure A.17), but no change in the number of hooks set per day (not shown). This pattern was not seen in the other stocks. Further investigation attributed this change to the move from LTCER reporting forms, and the reporting of multiple sets within two nautical miles of each other as a single record, to ERS forms and the reporting of each set individually regardless of how close they were to other sets. This characteristic of the data precludes the standardisation of longline CPUE by event for this stock.

3. AGE FREQUENCY DISTRIBUTION

3.1 Data sources and default stratification

Stratifying the catch into fisheries or areas for population modelling allows differences in age frequency distributions or sex ratios between the different parts of the population to be described; in particular, to see whether there are changes in selectivity and relative catch between strata over time. By having different fisheries in a stock assessment model, different selectivities enable the assessment model to remove the appropriate components of the population, i.e., the appropriate number of fish at each age and sex observed as caught in the fishery and estimate year class strength when possible.

Alternate strata were investigated in 2023 (Mormede et al. 2023a). Because the resulting scaled length frequency distributions were mostly insensitive to the choice of these four options of stratification, the existing stratification was maintained.

The strata used were as follows:

- bottom longline:
  - single stratum
  - catch, length, and otolith data from 1st May to 31st August
- bottom trawl:
  - three strata:
    - deep (≥ 498 m)
    - north shallow (< 498 m and latitude < 42.42° S)
    - south shallow (< 498 m and latitude ≥ 42.42° S)
  - catch, length, and otolith data from 1st June to 31st September
- trawl survey
  - core strata cover the 300 to 650 m depth range

The age and length data were sourced from scientific observer sampling (SOP and SMP programmes) of commercial vessels and from research surveys aboard the RV *Tangaroa* (TAN) and RV *Kaharoa* (KAH). Length frequency (LF) data were collected by observers on a trip-set basis, and otoliths were sampled from a subset of measured fish for age determination.

Three commercial fisheries were defined within the LIN7WC stock area (west coast South Island):

- Trawl (wcsiTRL): comprising methods midwater trawl (MW), bottom trawl (BT), midwater/bottom (MB), pair bottom trawl (PRB), and pair midwater trawl (PRM);
- Bottom longline (wcsiLLN); and
- Pot (wcsiPOT).

Two methods were used to generate catch-at-age compositions for input to the assessment model. Both methods were used to produce sex-disaggregated proportions-at-age (ages 1–28, with a plus group at age 28) for the period 1994–2025 where length and age data were available.

3.2 Age composition estimation

Standard age-length key method

The standard age-length key method, as used in previous analyses, was used to construct a year-specific age-length key (ALK) from otolith data, which was then applied to scaled observer length frequency data to produce age compositions. A minimum of 50 otoliths per year was used as the threshold for the generation of the ALK in each year.

The process consisted of the following steps:

1. Construction of the age-length key. For each year with sufficient otolith data, an ALK was constructed using 1 cm length bins. The ALK was built separately by sex (male, female, and unsexed categories). Where data were missing for a length bin, interpolation and extrapolation were applied to fill empty cells across the length range.
2. Scaled length compositions. Observer length frequency data were scaled to the total commercial catch using a weight-based approach, where individual fish weights were estimated from the sex-specific length-weight relationship. The length compositions were stratified by spatial stratum (for trawl) and scaled to total fishery catch per stratum using commercial landing data. Bootstrap resampling (100 iterations) was used to estimate coefficients of variation (CVs).
3. Then the year-specific ALK was applied to the scaled length compositions to produce proportions-at-age by sex with associated bootstrap CVs.

This method produces age compositions only for years where both otolith and length frequency data were available. No age compositions were generated for years lacking otolith samples (2004, 2009–2011, 2019, 2022).

Cohort-based age-length key method

The cohort method fits a generalised additive model (GAM) to the pooled otolith dataset across all years to produce a predictive ALK that incorporates spatial, temporal, and cohort effects. This method generates age compositions for all years with length frequency data, including years without direct otolith sampling. As the cohort model approach allows estimation of both spatial and seasonal effects in the age-length relationship, it can allow for estimation of the age compositions while adjusting for these factors.

The process consisted of the following steps:

1. GAM cohort model. A GAM was fitted to the complete otolith dataset with age as the response variable. The model incorporated the following predictors:
   - sex-specific smooth functions of fish length, s(length, by=sex), capturing sex-specific growth curves
   - sex-specific smooth functions of year, s(year, by=sex), capturing temporal trends in cohort strength
   - a spatial tensor product smooth of longitude and latitude, te(long, lat), capturing spatial variation in age composition
   - a fixed effect for sampling origin (observer-BLL, observer-trawl, or survey-trawl); and
   - a cyclic smooth of month, s(month, bs = “cc”), capturing seasonal effects.
2. Age assignment. For each measured fish in the observer length frequency data, the fitted GAM was used to predict a probability distribution over ages. Ages were then assigned stochastically by random sampling from this predicted distribution. For unsexed fish, the predicted age probabilities were averaged across male and female model predictions.
3. Scaled age compositions. Scaled age compositions were calculated directly from the age-assigned fish data using the same weight-based scaling and spatial stratification approach as the standard ALK method. Bootstrap resampling (100 iterations) was used for CV estimation.

Model diagnostics were evaluated using Probability Integral Transform (PIT) residuals, defined as:

$$PIT_i = F(a_i - 1) + U_i \cdot P(\text{age} = a_i)$$

where F is the cumulative distribution function, a_i is the observed age, and $U_i \sim \text{Uniform}(0,1)$. PIT values were transformed to the standard normal scale via $\Phi^{-1}(PIT_i)$ and model fits were assessed through QQ plots, histograms, and residual plots against length and year.

Effective sample sizes

The effective multinomial sample size (N_{eff}) was estimated for each fishery-year combination under both methods. The estimation procedure fitted the expected relationship between proportions-at-age and their bootstrap CVs:

$$CV = \sqrt{\frac{1-P}{N_{\text{eff}} \cdot P}}$$

where P is the proportion-at-age and N_{eff} is the effective sample size. The parameter N_{eff} was estimated by nonlinear least squares on the log scale, fitted separately for each sex and then combined. A minimum effective sample size of 1 was imposed.

Effective sample sizes from the traditional ALK method were generally higher than those from the cohort model (e.g., trawl fishery: 280–2538 vs. 75–936) as the ALK method did not include uncertainty from the age-length relationship in the application of the ALK.

3.3 Results

The length data for ling in LIN7WC was limited for bottom longlines and non-existent for potting (Figure B.1). Furthermore, age data from bottom longlines was very limited (Figure B.2), and expected to get more sparse with the introduction of cameras onboard small vessels removing some observer coverage (Mormede et al. 2024d). An in-depth investigation into the factors which drive age frequencies suggested that the fishing method (bottom trawl or bottom longlines) was not significant in the determination of age from length (see next section and Figure C.12). Therefore, longlines and trawl age length keys were combined for the determination of age compositions.

The two methods were compared for years where both produced age compositions (Figure B.3, Figure B.4, Figure B.5). Pearson correlations between traditional and cohort age compositions for overlapping years (2023–2025) ranged from 0.87 to 0.98. Both methods were also compared against previously used model inputs. Summary statistics (Pearson correlation, RMSE, mean absolute difference) were computed per year and fishery and suggested that these two approaches were similar for years where age data were available.

Effective sample sizes from the traditional ALK method were generally higher than those from the cohort model (e.g., trawl fishery: 280–2538 vs. 75–936) as the ALK method did not include uncertainty from the age-length relationship in the application of the ALK (Figure B.6).

4. UPDATE OF BIOLOGICAL PARAMETERS

4.1 Methods

Length-weight parameters

Length-weight parameters for ling used in the stock assessment were last updated in 2023 (Mormede et al. 2023a; Fisheries New Zealand 2026). This analysis updates the length-weight relationship by applying a log-linear regression to the available length and weight parameters, where $Weight = a \cdot (length)^b$, to estimate the a and b parameters for each sex separately—assuming a bias correction resulting from the transformation from log-space for a. Plots of residuals were checked for any evidence of fitting issues or trends over time.

Growth models

Age-length parameters for ling used in the stock assessment were last updated in 2023 (Mormede et al. 2023a; Fisheries New Zealand 2026).

This analysis updates the age-length relationship by applying the von Bertalanffy models to all available age data for the west coast of the South Island using either maximum likelihood estimation (MLE) or Bayesian inference.

MLE von Bertalanffy growth models were developed using the R package *growthVB* (Dunn 2025a). Bayesian von Bertalanffy growth models were developed using the R package *brms* which uses Stan (Stan Development Team 2020) to run Bayesian GLMs and non-linear models. Monotonic growth models were investigated in the past (Mormede et al. 2023a) but not carried forward and were therefore not replicated here. The von Bertalanffy (von Bertalanffy 1938) growth model was defined as:

$$\overline{L}_i = L_i^{\infty}\left(1 - \exp\left(-k_i\left(t - t_i^0\right)\right)\right) + \varepsilon \text{ where } \varepsilon \sim N(0, c\overline{L_i})$$

with:

$$\begin{aligned}
&L_\infty \sim N(100, 100^2)\\
&k \sim N(0, 100^2)\\
&t_0 \sim N(0, 100^2)\\
&\tau \sim N(0, 100^2)\\
&L_t \sim N(\mu_t, \sigma^2)\\
&\mu_t = L_\infty\left(1 - e^{-k(t-t_0)}\right)\\
&\sigma = \tau\mu_t
\end{aligned}$$

where L_∞ is asymptotic length (cm), k is the Brody growth coefficient, t_0 is the age at which the length is zero, μ_t is the expected length at age, and L_t is the predicted length at age. The mean length-at-age model was defined as:

$$\begin{aligned}
&\tau \sim N(0, 100^2)\\
&L_t \sim N(\eta_t, \sigma^2)\\
&\eta_t = f(t) + f(m)\\
&\sigma = \tau\eta_t
\end{aligned}$$

where $f(t)$is a monotonic increasing term for each age, and $f(m)$is a monotonic increasing term for each month. These models were run independently for each sex (i.e., no shared parameters).

The residuals of the growth models were investigated using the R package *gamInflu* (Dunn 2025b) to check for the potential effect of year, month, statistical area, depth and fishing method.

Maturity ogives

The maturity ogive for LIN 7WC was updated using the latest available information. Maturity at age was determined based on the maturity status of aged fish collected during the West Coast South Island resource surveys since 2000, which occurs mostly during spawning season.

Following the method of Horn (2005), stage 1 animals were assumed to be immature, stage 3–7 animals were assumed mature, and stage 2 animals were removed from the analysis as they represent a mixture of immature and mature fish. Bayesian maturity models were developed using the R package *brms* which uses Stan (Stan Development Team 2020) to run Bayesian GLMs and non-linear models. The model was defined as mature ~ age with a Bernoulli distribution. The year effect was tested to investigate if maturity had changed over time.

An alternative maturity ogive at length was calculated based on observer data collected during the spawning season (August to October for LIN 7WC). The maturity scale of observer data is different from that used on resource surveys. Following the method of Horn (2005), stage 1 animals were assumed to be immature, and stage 2–5 animals were assumed mature on the observer maturity scale.

4.2 Results

Length-weight parameters

Length-weight data were collected only during trawl surveys and as such have a limited temporal coverage within each survey year as well as a limited number of samples (Figure C.1 of Appendix C). The length-weight parameters derived in this analysis were very similar to those reported previously and used in the previous stock assessments (Table C.1 and Figure C.2). There were very limited differences in the pattern of residuals over time (Figure C.3), indicating no clear inter-annual pattern of weight at length for ling in LIN 7WC.

Growth models

All data available in the 't.age' database provided by Fisheries New Zealand were used whether they were collected during the west coast South Island trawl surveys or by observers. Most of the data available were from July and August, the months when the survey took place and when a large proportion of the trawl fishery operates (Figure C.4). Age data sampled from bottom longlines have been limited and sporadic (Figure C.4).

The MLE von Bertalanffy models had poor residuals for ages 3 (Figure C.5). The patterns of residuals per cohort indicated small variation in growth at a decadal scale; the lower growth rates for very early and late years were most likely confounded with the lack of a full range of fish for those cohorts (Figure C.6). The pattern of residual by year indicated a limited level of interannual variability (Figure C.7).

The resulting MLE growth curve was almost identical to those derived by Mormede et al. (2023a); the Bayesian growth curve was slightly different at older ages because parameter t_0 was fixed at -0.1 (Table C.2 and Figure C.8). This parameter represents the growth at age zero and is poorly estimated because of the lack of small ages (see also Figure C.5) and therefore Horn (2022) recommended it be fixed at a value of -0.1 for ling.

Posterior predictive distribution plots of the Bayesian model suggested that the data were represented well (Figure C.9), and that growth was similar in fish caught by the different fishing methods (Figure C.10). However, they also suggested that the growth in Statistical Area 032 was potentially different from that of the other Statistical Areas (Figure C.11). Data from this Statistical Area was moved from the LIN 5&6 stock to the LIN 7WC stock for stock assessment purposes in 2023 (Mormede et al. 2023a; Fisheries New Zealand 2026) based on the continuity of catches. Further investigations in growth and maturity in 2025 supported this decision (Horn 2022; Mormede et al. 2024b; Fisheries New Zealand 2026).

The regression on the residuals of the Bayesian von Bertalanffy growth model indicated that depth, year and month were highly significant whilst only the bottom precision harvesting method and Statistical Area 033 were significantly different (Figure C.12). These results indicate that the difference in growth between Statistical Area 032 and the rest of the population seen in Figure C.11 might be mostly explained by other parameters such as depth and time of fishing.

Maturity ogives

The trawl survey maturity data available are presented in Figure C.13. These indicate that less data has been available in recent years, and that the 2021 data in particular were marked by a higher-than-usual proportion of immature animals.

The modelled maturity at age by year for males and females separately indicate a stable maturity up to and including 2018 (Figure C.14), close to that developed by Horn (2005) and as used in previous stock assessments of LIN 7WC (Mormede et al. 2024e; Fisheries New Zealand 2026). However, 2021 (for both males and females) and 2024 (for males) were characterised by a right-shifted maturity ogive, by over 10 years for males (2024) and 5 years for females (2021). This result was surprising, particularly considering that resting animals (stage 2) were not included in the analysis. An investigation of gonad weight was unhelpful in elucidating this question.

An alternate data source comes from observer data. Very few fish that have been staged by observers also get aged, and therefore maturity at length was investigated for females (males tend to not be staged by observers). It is not as powerful an analysis as maturity at age due to the spread of ages at length and potential year variability of growth but might help corroborate patterns. Maturity at length showed little pattern between years, although 2021 and 2022 indicated a right-shifted maturity ogive, and 2023 a left-shifted ogive (Figure C.15).

4.3 Discussion

The length-weight relationship derived using all data up to and including 2025 had very similar parameter values to those used previously. Therefore existing values (Fisheries New Zealand 2026) were not updated. There was no indication of interannual variation or recent changes in the length-weight pattern.

The von Bertalanffy growth curve was updated using the recommendation of Horn (2022) to fix parameter t_0 at -0.1. The resulting curves were similar to existing ones within the main range of ages but differed slightly at the youngest and oldest ages. An investigation of the posterior density distributions indicated that Statistical Area 032 might be different from the rest of the region. However, further investigations into the residuals indicated that year, month and depth were more likely candidates to explain the variability in growth. Both posterior distributions and investigation of the residuals indicated that growth was not significantly different between bottom longlines and bottom trawl, and therefore the age length keys for those two fisheries could be combined. Such a combination would lead to a much larger sample size of age frequencies for the bottom longline fishery: age frequencies for the bottom longline fishery are currently only available for 2003, 2006, 2007, 2012, 2015 and 2021 (Mormede et al. 2024e) due to the paucity of age data for this fishery (Figure B.2).

The maturity ogive was right shifted in 2021 (females) and 2024 (males), which could be due to a later-than-usual spawning season of ling in LIN7WC. Continued annual monitoring of ling maturity is recommended, as well as the use of the existing maturity ogive for stock assessment purposes.

5. CPUE ANALYSES

5.1 Methods

Trawl CPUE

The standardised catch per unit effort used in the 2026 model used commercial bottom trawl catch and effort data starting in 1997 using trips that targeted hoki, hake, or ling (Mormede et al. 2023a, 2024e).

Standardised CPUE was calculated using generalised additive models (GAMs) using the package *gamInflu* (Dunn 2025b). The process carried out in 2023 was updated to follow best practice, in particular all parameters were included in the model, vessel was applied as a random effect, and latitude and longitude were applied as a combined tensor spline.

The unit of effort used for the standardisation was the catch per fishing event (in kilograms). All explanatory variables included in the models are detailed in Table D.1. Year was defined as calendar year to match the year definition to be used in the assessment model.

Details of the data selection for the bottom trawl CPUE indices are summarised in Table D.2 and were largely consistent with data used previously (Mormede et al. 2023a), in particular with regards to restricting the data to the June to September months when most of the trawl fishery operates. Because of the change over time in the reporting requirements, and in particular the number of species that require reporting (Figure A.6 and Figure A.7), fishing events where ling was not recorded in the top five species, or top five Quota Management System (QMS) species for ERS reporting, were assumed to have caught no ling; they were retained in the analysis but assigned a catch of 0 kg. This allows for comparability of the data reported over the entire time series. CPUE analyses were carried out on the 'core' fleet for each of the indices, aiming to keep at least 80% of the ling catch in each instance and cover the duration of the fishery with overlaps between fishing vessels over the entire time series (Figure D.1).

All the CPUE standardisations assumed a lognormal distribution for the positive catches and a binomial distribution for the probability of catch. Model fits were investigated using standard residual diagnostics.

A sensitivity analysis was carried out whereby a model was developed for each of the most fished statistical areas. Results were compared with the single area model, to investigate potential spatial effects not otherwise captured in the single area model.

Bottom longline CPUE

Prior to the early 2000s, longline catch and effort data were mostly recorded daily on CELR forms, rather than individually for each set on other form types (Figure A.1). To obtain as much of a time series of longline CPUE as possible, all longline data that were available on a set-by-set basis were 'rolled-up' into daily equivalents by vessel, day, and statistical area (e.g., using the approach of Starr 2008; Starr & Kendrick 2016). Furthermore, the recent change in reporting processes has affected the reporting of sets in this fishery and makes the use of set-by-set data problematic (see discussion above and Figure A.16 and Figure A.17). The catch was therefore assessed as the sum of all catches reported by each vessel in each day and statistical area and the number of hooks was assessed using the total of the number of hooks set on each day in each statistical area.

All explanatory variables included in the models are detailed in Table D.3. Because the longline fishery operates year-round (Figure A.4), data from all months were used. Details of the data selection for the bottom longline CPUE indices are summarised in Table D.4. As for bottom trawl data, because of the change over time in the reporting requirements, and in particular the number of species that require reporting (Figure A.6 and Figure A.7), fishing events where ling was not recorded in the top five species, or top five Quota Management System (QMS) species for ERS reporting, were assumed to have caught no ling; they were kept for the analysis but assigned a catch of 0 kg. This allows for comparability of the data reported over the entire time series. CPUE analyses were carried out on the 'core' fleet for each of the indices, aiming to keep at least 80% of the ling catch in each instance and cover the duration of the fishery with overlaps between fishing vessels over the entire time series (Figure D.2).

The longline CPUE standardisation assumed a lognormal distribution for the positive catches. There was a negligible number of longline sets with no ling catch, therefore a binomial model was not done for the standardised longline CPUE index. Model fits were investigated using standard residual diagnostics.

Three sensitivity trials were carried out. As for bottom trawling, a model was developed for each of the most fished statistical areas. Results were compared with the single area model, to investigate potential spatial effects not otherwise captured in the single area model. A second sensitivity run was carried out using data from 2008 only. Finally, a third sensitivity run was carried out with ERS data only (from 2018) to allow the use of the most detailed data available.

5.2 Results

Trawl CPUE

An update of the commercial trawl CPUE analysis carried out in 2023 (Mormede et al. 2023a) provided almost identical standardised CPUE indices to those previously calculated (Figure D.3). The indices obtained in this analysis were also consistent with the trend in the survey biomass series (Figure D.4).

The lognormal model explained 26% of the variance and the binomial model explained 29% of the deviance (Table D.5 and Table D.6). Vessel followed by location had the highest standardisation effect on both the lognormal and the binomial models (Figure D.5 and Figure D.6 respectively). Highest catch rates were obtained at depths of about 400 m, and for hoki target (Figure D.7 to Figure D.17).

Comparison between the single area model and the models for each statistical area individually did not suggest obvious localised departures from the overall CPUE trend (Figure D.18).

Bottom longline CPUE

The standardised lognormal CPUE indices for rolled-up bottom longline fishing for ling off the west coast of the South Island (LIN 7WC) were very similar to those calculated out in 2023 (Mormede et al. 2023a), and consistent with the survey biomass series (Figure D.3 and Figure D.4). It was also consistent with the commercial trawl CPUE indices obtained in this study but only since 2000; between 1997 and 2000 the trawl CPUE indices showed a large increase then decline, when the longline CPUE indices remained mostly flat (Figure D.4).

The lognormal model explained 43% of the variance (Table D.7 and Figure D.19). The number of hooks set had the highest standardisation effect on both of the models (Figure D.20). Highest catch rates were obtained at higher hooks set and in September (Figure D.21 to Figure D.24).

Comparison between the single area model and the models for each statistical area individually did not suggest obvious localised departures from the overall CPUE trend (Figure D.25). No binomial model was carried out as almost all longline sets caught ling in this fishery.

The sensitivity model runs carried out from 2008 (daily with location) or from 2018 (event-based with location) provided almost identical results to the main index (daily without location – Figure D.26) for the years where they overlapped.

5.3 Discussion

The two CPUE indices were generally consistent with each other from about 2000 and with the trawl survey series (Figure D.4). The trend between 1997 and 2000 did differ markedly between the bottom longline and bottom trawl CPUE indices, as previously reported (Mormede et al. 2023a). The trawl CPUE index was not estimated prior to 1997 as commercial logbook data prior to 1997 was deemed likely to be unreliable to use to derive CPUE indices (e.g., Dutilloy 2021; Mormede et al. 2023a).

The consistency of the CPUE indices with the trawl survey was improved slightly when applying a 1% annual learning rate in the CPUE (Figure D.4 and Figure D.27). A 1% CPUE learning rate has been implemented in rock lobster stock assessments for a number of years (Fisheries New Zealand 2026) and more recently for the stock assessment of ling in the Sub-Antarctic (Mormede et al. 2024c).

Although potting has only been operational in the LIN7WC fishery since 2021, an initial standardisation was carried out to check if the potting CPUE trend of this new fishery was similar to that of the bottom trawl and bottom longline fisheries. Results indicate that although a new fishery, the general standardised CPUE trend is similar to that of the other indices (Figure D.4). This series could be included in future stock assessments.

6. INPUTS INTO THE 2026 STOCK ASSESSMENT

6.1 Catches

Three fisheries were defined for the 2026 stock assessment: the trawl, longline and potting fisheries. There were no length data for the pot fishery in this region as there had been no observer sampling of ling on these trips, and for the purpose of the stock assessment it was given the longline fishery selectivity, following the approach used for ling on the Chatham Rise, where two potting trips have been observed and length data are available (Mormede et al. 2023b). In calculating total catches, the definition of the year was the calendar year.

The annual scaled-up catches per fishery and model year are summarised in Table E.1 of Appendix E.

6.2 Age compositions

The age compositions were updated to include a single annual age length key for bottom longline and bottom trawl combined. Progressions in year classes are shown in Figure B.3 to Figure B.6 Figure B.5.

6.3 Indices of abundance

The trawl survey biomass and associated scaled age compositions were used in the model. Because the trawl and longline fisheries covered different fishing grounds and the trawl survey only captured a small portion of the area covered by the longline fishery, both sets of CPUE indices were used in the stock assessment models (Table D.8).

7. MONITORING OF CHANGES

A qualitative evaluation of potential effects of environmental or climate change on the stock assessment where productivity may have changed due to environmental fluctuations or climate change is given in Table 2.

Table 2: Summary of the changes that may be due to climate change and environmental variability for west coast South Island ling.

Parameter	Summary
Recruitment	There is evidence of an extended recent period of low recent recruitment with a downwards trend
Age-at-maturity	The survey and observer data indicate a possible increase in the age at maturity of ling in LIN7WC in the 2021 to 2025 period, and/or a change in the timing of maturation
Stock recruitment steepness and variability	It is not known if there have been changes in the stock-recruit steepness parameter (*h*). Variability in recruitment has remained relatively constant.
Natural mortality	There was no information to determine if there have been changes in natural mortality over time

Parameter	Summary
Growth	Growth model (von Bertalanffy) residuals by year of observation and year indicates some annual variability in growth, but there was no clear trend over time
Length-weight	There was no evidence of change in length-weight relationship over time
Spatial distribution	Based on the trawl survey distributions, there was no evidence of spatial distribution changes over time
Stock structure	The stock structure does not seem to have changed (Horn 2022 and Mormede et al. 2024 vs Horn 2005)
Locations of spawning and site fidelity	Unknown, as there were few data from which to draw conclusions

8. POTENTIAL RESEARCH

Scaled age compositions for the longline fishery were calculated based on potentially non-representative length and age data collected between May and August. However, much of the fishery for longlines happens at other times of the year. A continued development of the cohort-based age composition analysis would help alleviate this issue.

In addition, few observations for pot fishing were available. The design of the sampling for length and otoliths, and the methods for the subsequent estimation of scaled length and age compositions should be evaluated. And, as the pot fishery has been steadily increasing since 2021 and is now a significant proportion of the catch, length data and age readings are required to develop an age frequency and associated selectivity for this fishery.

Age at maturity observations were unusual in 2021 and 2024 and the age-at-maturity relationship should continue to be monitored.

9. FULFILMENT OF BROADER OUTCOMES

Whakapapa links all people back to the land, sea, and sky, and our obligations to respect the physical world. This research aims to ensure the long-term sustainability of ling stocks, for the good of the wider community (including stakeholders and the public) and the marine ecosystems that ling inhabit. This project supports Māori and regional businesses, diversity and inclusion, and our research is inextricably linked to the moana from the work it carries out and the tangata whenua it supports.

As part of this project, the team has continued to build capacity and capability in fisheries science and stock assessment, its commitment to zero waste and carbon neutrality, environmental stewardship and social responsibility. The companies involved are based in New Zealand, some of which are region-based, directly contributing to the New Zealand economy and regional economy.

10. ACKNOWLEDGEMENTS

We thank the Fisheries New Zealand Data Management Team for the data extracts and additional information used in these analyses and their assistance in its interpretation. We thank Gretchen Skea (Fisheries New Zealand Deepwater Fisheries Assessment Working Group Chair), Ian Tuck and Ian Blixt (Fisheries New Zealand reviewers) and members of the Deepwater Fisheries Assessment Working Group for their discussions on this work. This work was funded by Fisheries New Zealand under Objective 1 of project LIN2025-01 with additional funding by Seafood New Zealand: Deepwater Council for running additional projections.

11. REFERENCES

Dunn, A. (2003). Investigation of evidence of area misreporting of landings of ling in LIN 3, 4, 5, 6, & 7 from TCEPR records in the fishing years 1989-90 to 2000-01. Final Research Report to the Ministry of Fisheries. Project HAK2001/01 (8). NIWA, Wellington, 21 p.

Dunn, A. (2025a). growthVB: Von Bertalanffy Growth Curve Estimation with Heteroscedastic Errors.

Dunn, A. (2025b). gamInflu: Influence Analysis Tools for Generalized Additive Models in R.

Dutilloy, A. (2021). Fishery description and CPUE for ling (*Genypterus blacodes*) off the west coast South Island (LIN 7WC), 1986-87 to 2018-19. *New Zealand Fisheries Assessment Report 2021/12.* 106 p.

Edwards, C.T.T. (2017). Development of natural mortality priors for ling (*Genypterus blacodes*) stock assessments in New Zealand. *New Zealand Fisheries Assessment Report 2017/55*. 32 p.

Fisheries New Zealand (2026). Fisheries Assessment Plenary, May 2026: stock assessments and stock status. Compiled by the Fisheries Science Team. Ministry for Primary Industries, Wellington, New Zealand.

Horn, P.L. (2005). A review of the stock structure of ling (*Genypterus blacodes*) in New Zealand waters. *New Zealand Fisheries Assessment Report 2005/59*. 41 p.

Horn, P.L. (2022). A synopsis of the biology of ling (*Genypterus blacodes*) and a history of its fishery and assessment in New Zealand. *New Zealand Fisheries Assessment Report 2022/27*. 82 p.

Mormede, S.; Dunn, A.; Webber, D.N. (2022). Descriptive analysis of ling (*Genypterus blacodes*) on the Chatham Rise (LIN 3&4) up to 2020–21 and inputs for the 2022 stock assessment. *New Zealand Fisheries Assessment Report 2022/64*. 85 p.

Mormede, S.; Dunn, A.; Webber, D.N. (2023a). Descriptive analysis of ling off the west coast of the South Island (LIN 7WC) up to 2021–22 and inputs for the 2023 stock assessment. *New Zealand Fisheries Assessment Report 2023/51.* 91 p.

Mormede, S.; Dunn, A.; Webber, D.N. (2023b). Stock assessment of ling (*Genypterus blacodes*) on the Chatham Rise (LIN 3&4) for the 2021–22 fishing year. *New Zealand Fisheries Assessment Report 2023/14*. 39 p.

Mormede, S.; Dunn, A.; Webber, D.N. (2024a). Descriptive analysis of ling in the Sub-Antarctic (LIN 5&6 and LIN 6B) up to 2023 and inputs for the 2024 stock assessment. *New Zealand Fisheries Assessment Report 2024/82*. 94 p.

Mormede, S.; Dunn, A.; Webber, D.N. (2024b). Stock hypotheses for ling in the Sub-Antarctic (LIN 5&6 and LIN 6B). *New Zealand Fisheries Assessment Report 2024/83*. 13 p.

Mormede, S.; Dunn, A.; Webber, D.N. (2024c). The 2024 stock assessment of ling (*Genypterus blacodes*) in the Sub-Antarctic (LIN5&6 and LIN 6B). *New Zealand Fisheries Assessment Report 2024/84*. 28 p.

Mormede, S.; Dunn, A.; Webber, D.N. (2024d). Longline observer data coverage in ling fisheries and their use in stock assessments. *New Zealand Fisheries Assessment Report 2024/85*. 30 p.

Mormede, S.; Dunn, A.; Webber, D.N. (2024e). The 2023 stock assessment of ling (*Genypterus blacodes*) off the west coast South Island (LIN 7WC). *New Zealand Fisheries Assessment Report 2024/02*. 23 p.

R Core Team (2025). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.

Stan Development Team (2020). Stan Modelling Language: User’s Guide and Reference Manual Version 2.24. Stan Governing Body.

Starr, P.J. (2008). Procedure for merging MFish landing and effort data. Unpublished report held by the Ministry for Primary Industries. Ministry for Primary Industries, Wellington, N.Z., 18 p.

Starr, P.J.; Kendrick, T.H. (2016). SCH 1, 2, 3, 4, 5, 7 and 8 fishery characterisation and CPUE report. *New Zealand Fisheries Assessment Report 2016/64.* 255 p.

von Bertalanffy, R. (1938). A quantitative theory of organic growth (Inquiries on growth laws. II). *Human Biology 10*, 181–213.

12. APPENDIX A – DESCRIPTION OF THE FISHERY

Table A.1: Ling TACC (in tonnes) per QMA by fishing year (Fisheries New Zealand 2026).

Fishing year	LIN 1&9	LIN 2	LIN 3	LIN 4	LIN 5	LIN 6	LIN 7&8	LIN 10	Total
1987	200	910	1 850	4 300	2 500	7 000	1 960	10	18 730
1988	237	918	1 909	4 400	2 506	7 000	2 008	10	18 988
1989	237	955	1 917	4 400	2 506	7 000	2 150	10	19 175
1990	265	977	2 137	4 401	2 706	7 000	2 176	10	19 672
1991	265	977	2 160	4 401	2 706	7 000	2 192	10	19 711
1992	265	977	2 160	4 401	2 706	7 000	2 192	10	19 711
1993	265	980	2 162	4 401	2 706	7 000	2 212	10	19 737
1994	265	980	2 167	4 401	2 706	7 000	2 213	10	19 741
1995	265	980	2 810	5 720	3 001	7 100	2 225	10	22 111
1996	265	980	2 810	5 720	3 001	7 100	2 225	10	22 111
1997	265	982	2 810	5 720	3 001	7 100	2 225	10	22 113
1998	265	982	2 810	5 720	3 001	7 100	2 225	10	22 113
1999	265	982	2 810	5 720	3 001	7 100	2 225	10	22 113
2000	265	982	2 810	5 720	3 001	7 100	2 225	10	22 113
2001	265	982	2 060	4 200	3 001	7 100	2 225	10	19 843
2002	265	982	2 060	4 200	3 001	7 100	2 225	10	19 843
2003	400	982	2 060	4 200	3 001	7 100	2 225	10	19 978
2004	400	982	2 060	4 200	3 001	7 100	2 225	10	19 978
2005	400	982	2 060	4 200	3 595	8 505	2 225	10	21 977
2006	400	982	2 060	4 200	3 595	8 505	2 225	10	21 977
2007	400	982	2 060	4 200	3 595	8 505	2 225	10	21 977
2008	400	982	2 060	4 200	3 595	8 505	2 225	10	21 977
2009	400	982	2 060	4 200	3 595	8 505	2 225	10	21 977
2010	400	982	2 060	4 200	3 595	8 505	2 474	10	22 226
2011	400	982	2 060	4 200	3 595	8 505	2 474	10	22 226
2012	400	982	2 060	4 200	3 595	8 505	2 474	10	22 226
2013	400	982	2 060	4 200	3 595	8 505	2 474	10	22 226
2014	400	982	2 060	4 200	3 955	8 505	3 080	10	23 192
2015	400	982	2 060	4 200	3 955	8 505	3 080	10	23 192
2016	400	982	2 060	4 200	3 955	8 505	3 080	10	23 192
2017	400	982	2 060	4 200	3 955	8 505	3 080	10	23 192
2018	400	982	2 060	4 200	3 955	8 505	3 080	10	23 192
2019	400	982	2 060	4 200	4 735	8 505	3 080	10	23 972
2020	400	982	2 060	4 200	4 735	8 505	3 387	10	24 279
2021	400	982	2 060	4 200	4 735	8 505	3 387	10	24 279
2022	400	982	2 060	4 200	4 735	8 505	3 387	10	24 279
2023	400	982	2 060	4 200	5 208	8 505	3 387	10	24 752
2024	400	982	2 060	4 200	5 208	8 505	3 387	10	24 752
2025	400	982	2 060	4 200	5 208	8 505	3 387	10	24 752

Table A.2: Ling catch (in tonnes) by QMA and fishing year as reported on catch and effort forms.

Fishing year	LIN 1	LIN 2	LIN 3	LIN 4	LIN 5	LIN 6	LIN 7	LIN 10	Other	Total
1990	54	523	1 231	443	1 459	802	2 370	0	21	6 903
1991	138	829	2 062	2 153	2 382	2 360	2 010	-	16	11 950
1992	183	672	2 101	4 346	3 674	3 238	1 875	0	29	16 119
1993	302	738	1 894	3 530	3 052	5 562	1 969	0	18	17 065
1994	289	636	1 842	3 701	3 121	3 248	1 844	-	40	14 722
1995	405	717	2 061	4 376	3 658	3 851	2 646	-	442	18 155
1996	311	782	2 452	4 085	4 731	3 804	2 473	-	108	18 745
1997	690	741	2 189	3 468	4 729	4 921	2 397	0	144	19 279
1998	339	770	2 240	4 230	4 303	5 510	2 506	0	248	20 148
1999	301	770	2 054	3 906	3 992	4 492	2 738	0	80	18 333
2000	366	778	2 188	3 969	3 834	5 391	2 614	0	8	19 146
2001	312	922	1 830	3 415	3 915	5 206	2 975	-	9	18 584
2002	277	801	1 779	3 214	3 774	5 414	2 614	-	4	17 877
2003	216	746	2 076	2 719	3 747	5 252	2 313	0	2	17 070
2004	200	817	1 605	2 385	4 052	5 698	2 446	-	1	17 204
2005	223	741	1 311	2 570	4 913	4 025	2 077	-	4	15 863
2006	289	702	1 341	1 663	4 515	2 250	2 016	-	42	12 819
2007	228	740	1 814	1 942	5 380	2 770	1 792	-	4	14 670
2008	359	690	1 604	2 306	5 192	3 275	1 899	-	18	15 344
2009	298	560	1 525	1 815	3 867	1 706	1 866	-	3	11 640
2010	354	506	1 524	1 844	3 882	1 494	1 987	0	1	11 593
2011	389	598	1 445	1 398	4 086	968	2 220	-	0	11 105
2012	353	428	1 076	2 016	4 291	1 287	2 071	-	2	11 523
2013	346	514	1 188	1 918	5 860	1 218	2 386	-	0	13 431
2014	365	553	1 218	2 041	4 945	2 061	2 531	-	0	13 713
2015	369	561	1 016	1 877	5 147	1 757	2 601	0	1	13 330
2016	388	599	1 160	2 267	4 647	1 290	2 741	-	2	13 093
2017	382	904	1 572	2 213	5 114	2 110	2 743	-	4	15 041
2018	378	1 006	1 914	2 375	5 204	3 183	2 713	-	2	16 776
2019	354	857	1 746	1 849	5 816	2 308	2 552	-	6	15 488
2020	348	640	1 449	1 601	5 255	2 867	2 782	-	2	14 945
2021	283	551	1 321	1 914	5 954	2 695	2 830	-	36	15 585
2022	327	494	1 021	2 324	5 965	2 661	2 918	-	0	15 711
2023	253	429	1 191	1 690	5 321	3 894	3 176	-	0	15 953
2024	259	406	1 747	2 075	4 952	3 741	2 838	-	0	16 017
2025	193	588	1 530	1 948	5 804	4 063	2 578	-	1	16 706
Total	11 121	24 309	59 317	91 586	160 533	116 372	87 107	0	1 298	551 646

Table A.3: Ling catch (in tonnes) by QMA and fishing year as reported on MHR forms.

Fishing year	LIN 1	LIN 3	LIN 4	LIN 5	LIN 6	LIN 7	Total
1990	193	1 221	108	1 536	210	2 962	6 230
1991	112	2 107	953	2 486	1 749	2 548	9 954
1992	222	2 371	2 784	2 069	2 272	2 630	12 347
1993	260	2 346	4 557	4 315	5 366	2 462	19 308
1994	235	2 532	4 174	2 681	5 537	2 425	17 583
1995	246	2 139	4 253	2 741	5 347	2 311	17 038
1996	253	2 648	5 272	1 827	6 466	2 883	19 349
1997	246	2 995	4 387	3 434	6 224	3 074	20 359
1998	331	3 093	4 703	3 630	7 146	3 044	21 946
1999	318	2 930	5 384	3 301	6 531	3 057	21 521
2000	215	2 788	4 369	3 329	6 639	3 149	20 490
2001	317	2 580	3 804	3 352	7 207	3 327	20 586
2002	303	2 164	3 602	3 295	5 945	3 219	18 529
2003	246	2 529	2 997	2 939	6 283	2 918	17 912
2004	249	1 990	2 618	2 899	7 032	2 926	17 713
2005	283	1 597	2 758	3 584	5 506	2 522	16 250
2006	364	1 711	1 769	3 522	3 553	2 479	13 398
2007	301	2 089	2 113	3 731	4 696	2 295	15 226
2008	381	1 778	2 383	4 401	4 246	2 282	15 471
2009	320	1 751	2 000	3 232	2 977	2 223	12 503
2010	386	1 718	2 026	3 034	2 414	2 446	12 024
2011	438	1 665	1 572	3 856	1 335	2 800	11 667
2012	384	1 292	2 305	3 649	2 047	2 771	12 449
2013	383	1 475	2 181	3 610	3 102	3 010	13 761
2014	380	1 442	2 373	3 935	3 221	3 200	14 551
2015	374	1 325	2 246	3 924	3 115	3 344	14 329
2016	422	1 440	2 659	3 868	2 222	3 351	13 963
2017	404	1 808	2 565	4 051	3 323	3 428	15 579
2018	415	2 171	2 636	4 034	4 846	3 487	17 589
2019	383	2 016	2 044	4 596	3 706	3 059	15 804
2020	371	1 685	1 778	4 678	3 972	3 216	15 701
2021	319	1 489	2 129	4 949	3 917	3 308	16 111
2022	353	1 175	2 604	5 050	3 881	3 325	16 389
2023	268	1 366	1 892	4 907	4 781	3 540	16 754
2024	296	1 965	2 359	4 763	4 414	3 216	17 012
2025	153	1 498	1 475	4 607	4 912	2 370	15 016
Total	11 124	70 889	99 831	129 820	156 141	104 608	572 413

Table A.4: Ling catch (in tonnes) by stock and fishing year as reported on catch and effort returns and scaled to MHR returns.

Fishing year	LIN 3&4	LIN 5&6	LIN 6B	LIN 7CK	LIN 7WC	OTHER	Total
1990	1 459	2 674	4	553	2 823	506	8 020
1991	2 897	4 299	21	618	2 394	507	10 735
1992	4 868	4 009	571	472	2 544	869	13 333
1993	6 562	9 049	959	404	2 355	911	20 240
1994	6 333	7 122	1 410	315	2 336	982	18 499
1995	6 245	7 684	445	316	2 288	1 293	18 271
1996	7 816	7 685	619	467	2 829	1 000	20 416
1997	7 163	9 312	359	532	3 147	1 074	21 587
1998	7 548	10 327	391	399	3 254	1 432	23 351
1999	8 168	9 108	637	384	3 277	940	22 513
2000	7 073	8 953	1 007	445	3 233	867	21 577
2001	6 227	9 229	1 329	451	3 418	963	21 617
2002	5 502	8 739	645	382	3 264	1 034	19 567
2003	5 275	8 298	1 029	483	2 960	865	18 910
2004	4 442	9 093	994	465	2 871	893	18 759
2005	4 236	9 115	48	461	2 536	793	17 191
2006	3 299	7 112	72	334	2 525	878	14 220
2007	4 001	8 329	256	281	2 318	918	16 103
2008	4 056	8 265	446	205	2 320	990	16 281
2009	3 608	6 074	232	154	2 235	837	13 140
2010	3 589	5 573	2	100	2 425	921	12 610
2011	2 947	5 242	55	172	2 882	1 038	12 337
2012	3 293	5 764	4	142	2 930	823	12 956
2013	3 460	6 730	4	190	3 101	856	14 339
2014	3 615	6 840	290	197	3 360	923	15 225
2015	3 387	6 940	38	182	3 508	948	15 003
2016	4 026	5 665	214	222	3 559	983	14 668
2017	4 155	6 345	815	285	3 773	1 233	16 604
2018	4 542	8 475	252	378	3 851	1 198	18 696
2019	3 856	8 000	222	278	3 271	1 122	16 748
2020	3 252	8 473	254	150	3 270	1 060	16 459
2021	3 505	8 192	637	113	3 451	893	16 792
2022	3 719	8 795	218	109	3 346	733	16 921
2023	3 225	9 624	98	152	3 533	581	17 213
2024	4 190	8 692	538	189	3 229	612	17 452
2025	2 931	8 987	455	135	2 467	554	15 529
Total	164 470	272 813	15 570	11 115	106 883	33 030	603 882

Table A.5: Ling catch (in tonnes) for the LIN 7WC biological stock (including Statistical Area 032) by form type and fishing year as reported on catch and effort returns.

Fishing year	CELR	LTCER	ERS - Lining	TCEPR	TCER	ERS - Trawl	Other	Total
1990	646	0	0	1 624	0	0	0	2 270
1991	946	0	0	1 000	0	0	0	1 946
1992	1 150	0	0	712	0	0	0	1 863
1993	1 048	0	0	829	0	0	0	1 877
1994	1 025	0	0	757	0	0	0	1 782
1995	1 106	0	0	1 501	0	0	0	2 607
1996	1 374	0	0	1 225	0	0	0	2 599
1997	1 225	0	0	1 252	0	0	0	2 477
1998	1 192	0	0	1 482	0	0	0	2 674
1999	1 229	0	0	1 649	0	0	0	2 878
2000	1 178	0	0	1 486	0	0	0	2 664
2001	1 196	0	0	1 873	0	0	0	3 069
2002	858	0	0	1 784	0	0	0	2 642
2003	918	0	0	1 421	0	0	0	2 338
2004	815	0	0	1 573	0	0	13	2 401
2005	958	0	0	1 098	0	0	0	2 056
2006	788	0	0	1 261	0	0	2	2 052
2007	883	0	0	824	0	0	88	1 795
2008	115	894	0	612	245	0	43	1 909
2009	125	763	0	635	285	0	43	1 850
2010	26	840	0	730	317	0	47	1 960
2011	9	895	0	994	364	0	26	2 288
2012	13	834	0	924	347	0	22	2 141
2013	51	937	0	1 128	341	0	0	2 457
2014	54	1 132	0	1 121	333	0	22	2 661
2015	19	1 138	0	1 325	262	0	0	2 745
2016	16	1 149	0	1 346	340	0	40	2 890
2017	19	1 104	0	1 501	392	0	5	3 021
2018	18	1 160	0	0	342	1 475	7	3 002
2019	13	543	576	0	95	1 323	176	2 726
2020	0	5	1 462	0	0	1 357	24	2 848
2021	0	0	1 651	0	0	1 181	125	2 957
2022	0	0	1 516	0	0	1 232	193	2 941
2023	0	0	1 062	0	0	1 348	769	3 180
2024	0	0	1 096	0	0	1 044	688	2 827
2025	0	0	978	0	0	940	733	2 651
Total	19 017	11 395	8 340	33 668	3 661	9 899	3 065	89 045

Table A.6: Ling catch (in tonnes) for the LIN 7WC biological stock (including Statistical Area 032) by gear type and target species by fishing year as reported on catch and effort returns for the main gear types. Potting is defined as catches from the following forms: CP (cod pot), CRP (cray pot), OCP (octopus pot), POT, FP (fish pot), and RLP (rock lobster pot). Bottom trawl also includes midwater trawl within 5 m of the bottom.

Fishing	Bottom trawl				Bottom longline		Midwater trawl		Potting		Other	Total
	LIN	HOK	HAK	Other	LIN	Other	HOK	Other	LIN	Other		
1990	58	577	1	92	125	1	1 044	0	0	0	371	2 270
1991	58	381	0	61	351	2	649	0	0	0	444	1 946
1992	94	400	24	126	608	25	263	0	0	0	322	1 863
1993	135	565	30	143	633	33	164	13	0	0	161	1 877
1994	30	537	30	84	679	21	178	11	0	0	212	1 782
1995	21	681	6	155	812	57	734	18	0	0	123	2 607
1996	16	670	10	124	977	12	612	6	0	0	173	2 599
1997	41	772	15	166	895	24	441	4	0	0	119	2 477
1998	8	836	16	82	880	33	679	10	0	0	130	2 674
1999	4	1 182	39	159	860	60	500	5	0	0	69	2 878
2000	13	1 044	12	100	685	62	637	15	0	0	97	2 664
2001	0	1 468	9	56	868	47	567	5	1	0	50	3 069
2002	8	1 456	19	45	649	9	391	3	0	0	63	2 642
2003	21	1 100	39	45	655	24	396	2	0	0	57	2 338
2004	31	1 235	50	46	658	12	331	2	0	0	36	2 401
2005	79	847	69	91	702	25	211	1	0	0	31	2 056
2006	70	980	158	75	547	14	167	1	0	0	40	2 052
2007	76	458	152	187	711	34	85	2	0	0	91	1 795
2008	197	305	227	111	938	71	17	0	0	0	42	1 909
2009	164	322	203	205	848	37	25	0	0	0	44	1 850
2010	213	516	124	154	838	27	39	1	0	0	48	1 960
2011	251	653	209	155	847	56	89	0	0	0	28	2 288
2012	173	731	124	127	809	39	114	0	0	0	22	2 141
2013	111	972	154	132	919	35	101	0	0	0	34	2 457
2014	107	887	144	116	1 146	44	197	0	0	0	18	2 661
2015	86	987	205	72	1 133	25	237	0	0	0	0	2 745
2016	105	1 028	99	146	1 114	35	307	0	16	0	40	2 890
2017	159	1 191	61	101	1 108	18	360	0	1	0	20	3 021
2018	110	1 172	35	54	1 135	28	341	0	13	0	114	3 002
2019	119	782	35	132	1 288	15	304	1	6	0	43	2 726
2020	348	589	29	140	1 398	69	227	0	0	0	47	2 848
2021	345	474	23	170	1 555	96	161	0	87	35	10	2 957
2022	291	573	14	118	1 464	52	234	0	192	0	3	2 941
2023	461	460	50	216	1 047	15	158	2	759	0	11	3 180
2024	324	453	5	132	1 013	83	126	3	688	0	2	2 827
2025	306	447	3	69	954	24	116	0	733	0	0	2 651
Total	4 635	27 732	2 421	4 189	31 850	1264	11 201	106	2 496	36	3116	89 045

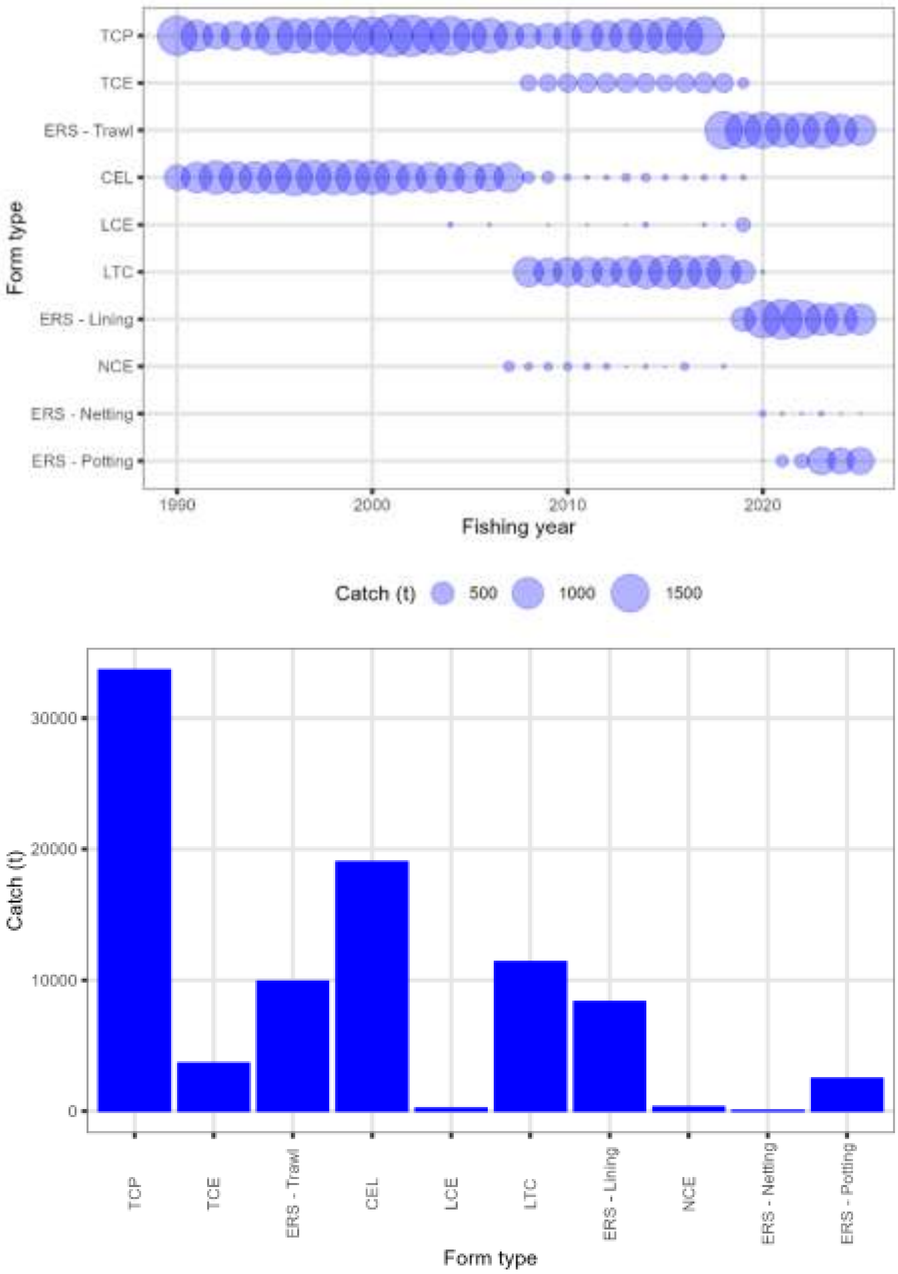


Figure A.1: LIN 7WC distribution of annual ling catch reported on catch and effort returns by form type: Trawl Catch Effort and Processing Return (TCP), Trawl Catch Effort Return (TCE), Electronic Reporting System return (ERS), Catch Effort Landing Return (CEL), Lining Catch Effort Return (LCE), Lining Trip Catch Effort return (LTC), and Netting Catch Effort return (NCE).

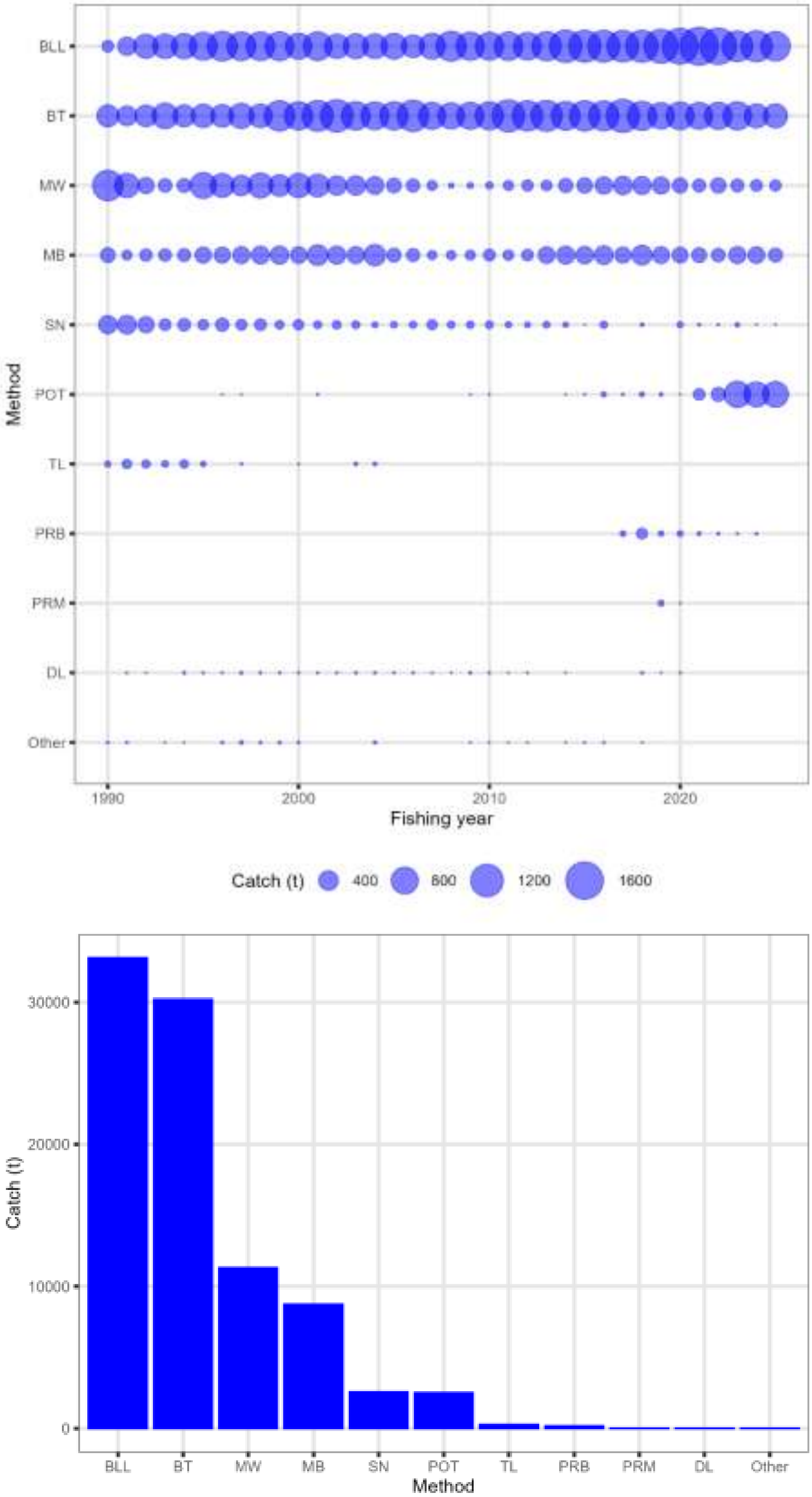


Figure A.2: LIN 7WC distribution of annual ling catch reported on catch and effort returns by method and fishing year. Method is bottom longlining (BLL), bottom trawl (BT), midwater trawl (MW), midwater trawl within 5 m of the bottom (MB – code defined within the analysis), set net (SN), all potting methods (POT – code defined within the analysis), trot line (TL), precision bottom trawl (PRB), precision midwater trawl (PRM), drop/Dahn line (DL), and all other codes (Other).

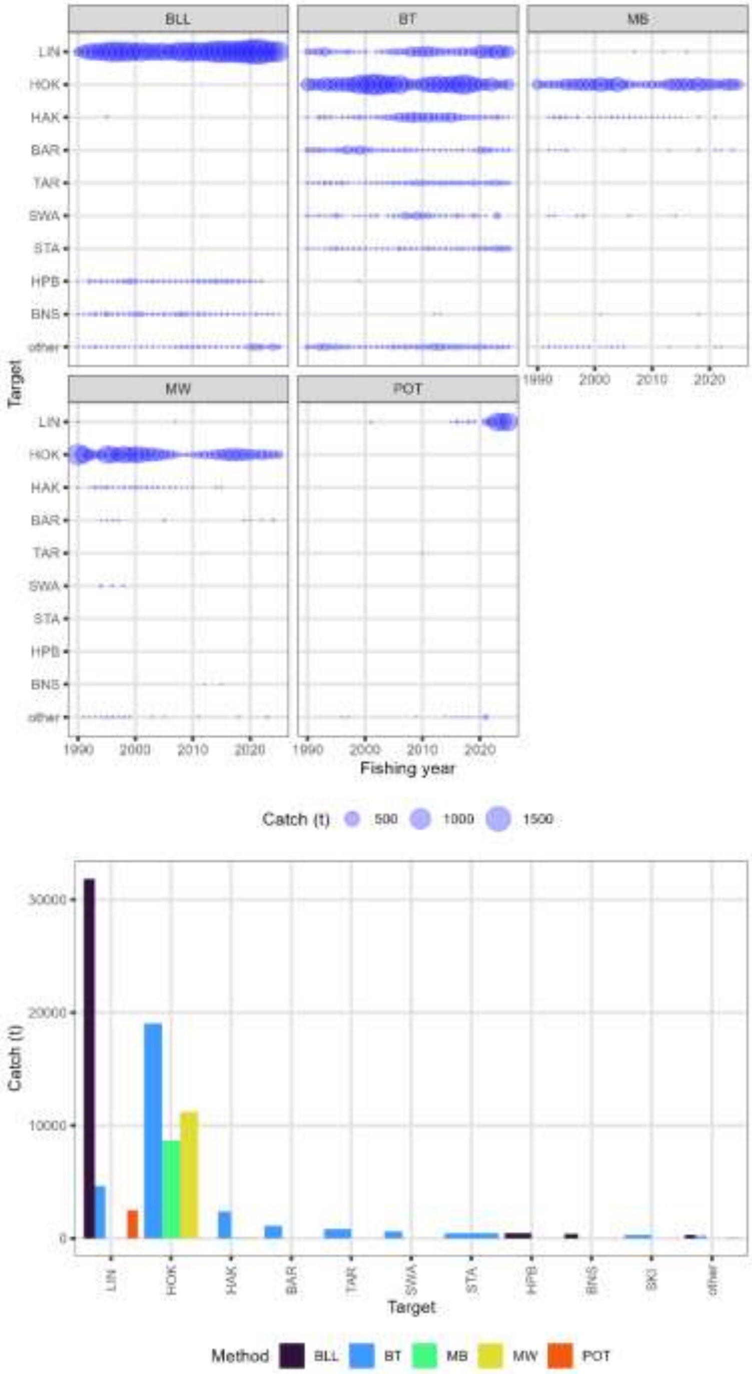


Figure A.3: LIN 7WC distribution of annual ling catch reported on catch and effort returns by target species for bottom longline (BLL), bottom trawl (BT), midwater trawl (MW), midwater trawls within 5 m of the bottom (MB – code defined within the analysis above), and all potting methods (POT – code defined within the analysis) gears separately. Target is barracouta (BAR – *Thyrsites atun*), bluenose (BNS – *Hyperoglyphe antarctica*), hake (HAK), hoki (HOK), hāpuku and bass (HPB – *Polyprion oxygeneios, P. americanus*), ling (LIN), gemfish (SKI – *Rexea* spp.), giant stargazer (STA – *Kathetostoma* spp.), silver warehou (SWA – *Seriolella punctata*), tarakihi (TAR – *Nemadactylus macropterus, Nemadactylus* sp.), and all other targets combined (other).

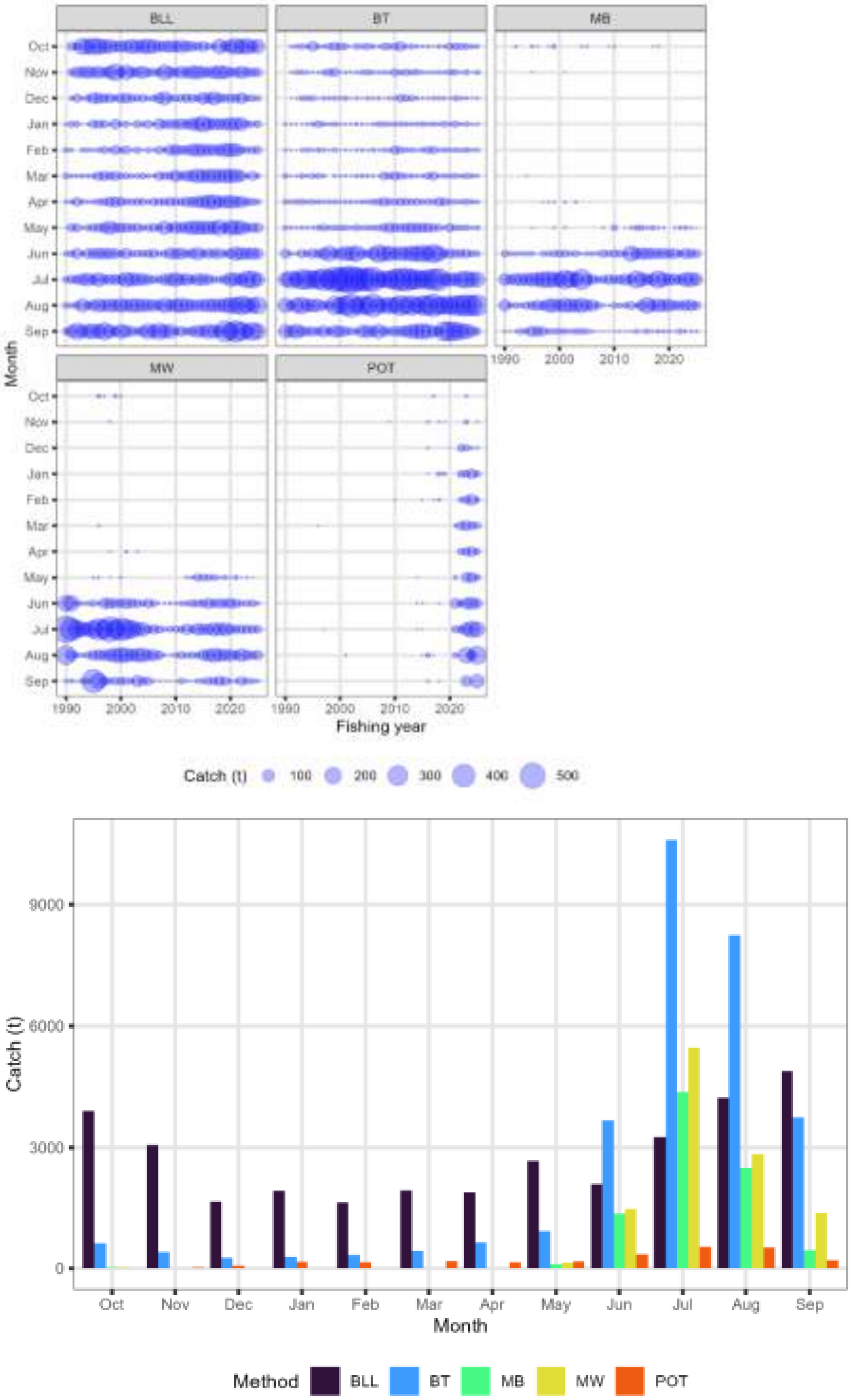


Figure A.4: LIN 7WC distribution of annual ling catch reported on catch and effort returns by month for bottom longline (BLL), bottom trawl (BT), midwater trawl (MW), midwater trawl within 5 m of the bottom (MB – code defined within the analysis), and all potting methods (POT – code defined within the analysis above) gears separately.

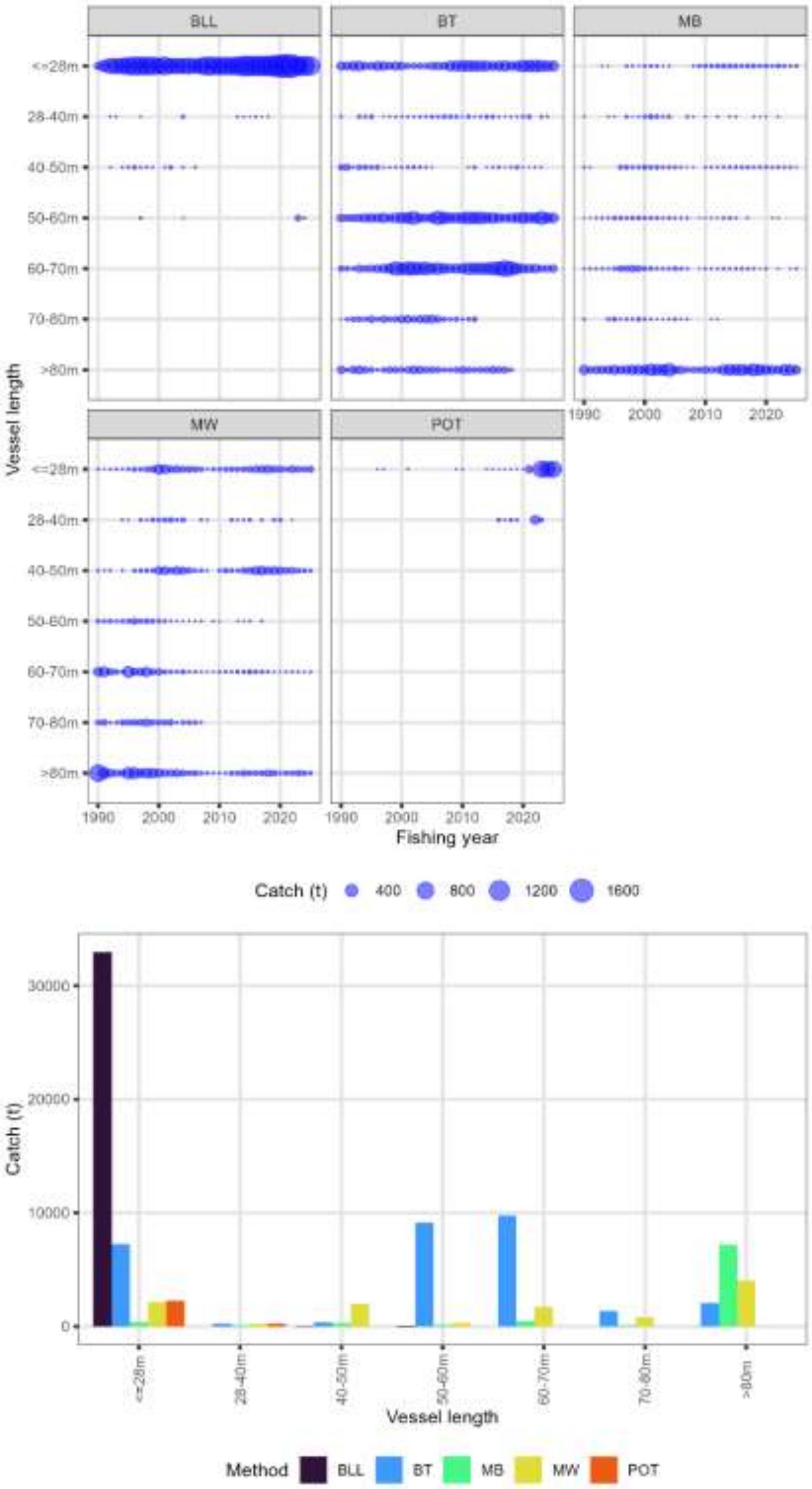


Figure A.5: LIN 7WC distribution of annual ling catch reported on catch and effort returns by vessel length for bottom longline (BLL), bottom trawl (BT), midwater trawl (MW), midwater trawl within 5 m of the bottom (MB – code defined within the analysis above), and all potting methods (POT – code defined within the analysis) gears separately.

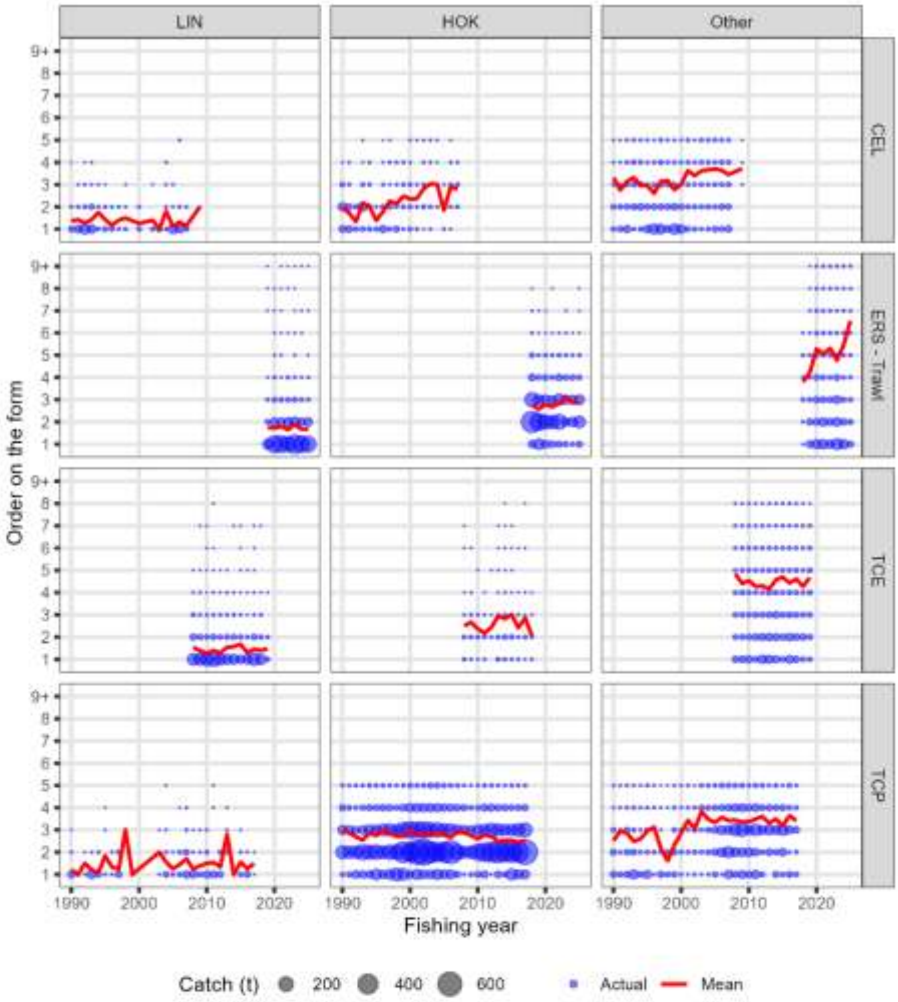


Figure A.6: LIN 7WC distribution of annual ling catch reported on catch and effort returns by order (where greatest catch is 1) reported in the forms for bottom trawl major target species (ling – LIN, hoki – HOK, or other), and catch weighted annual mean order reported (red lines). The order is for QMS species for ERS forms and all species otherwise, matching the reporting requirements. Form type is Trawl Catch Effort and Processing Return (TCP), Trawl Catch Effort Return (TCE), Electronic Reporting System Return (ERS), and Catch Effort Landing Return (CEL).

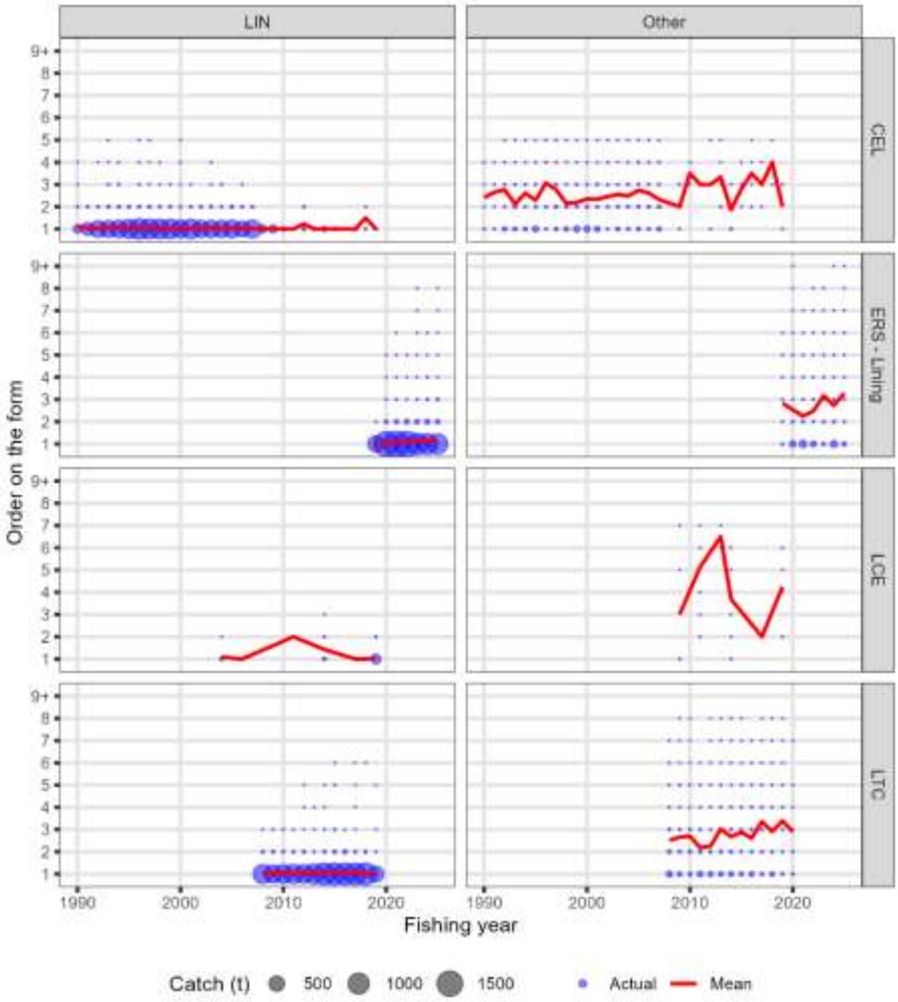


Figure A.7: LIN 7WC annual ling catch reported on catch and effort returns by order reported on the forms for longline gears (where greatest catch is 1) and target species (ling – LIN or other), and catch weighted annual mean order reported (red lines). The order is for QMS species for ERS forms and all species otherwise, matching the reporting requirements. Form type is Electronic Reporting System Return (ERS), Catch Effort Landing Return (CEL), Lining Catch Effort Return (LCE), and Lining Trip Catch Effort Return (LTC).

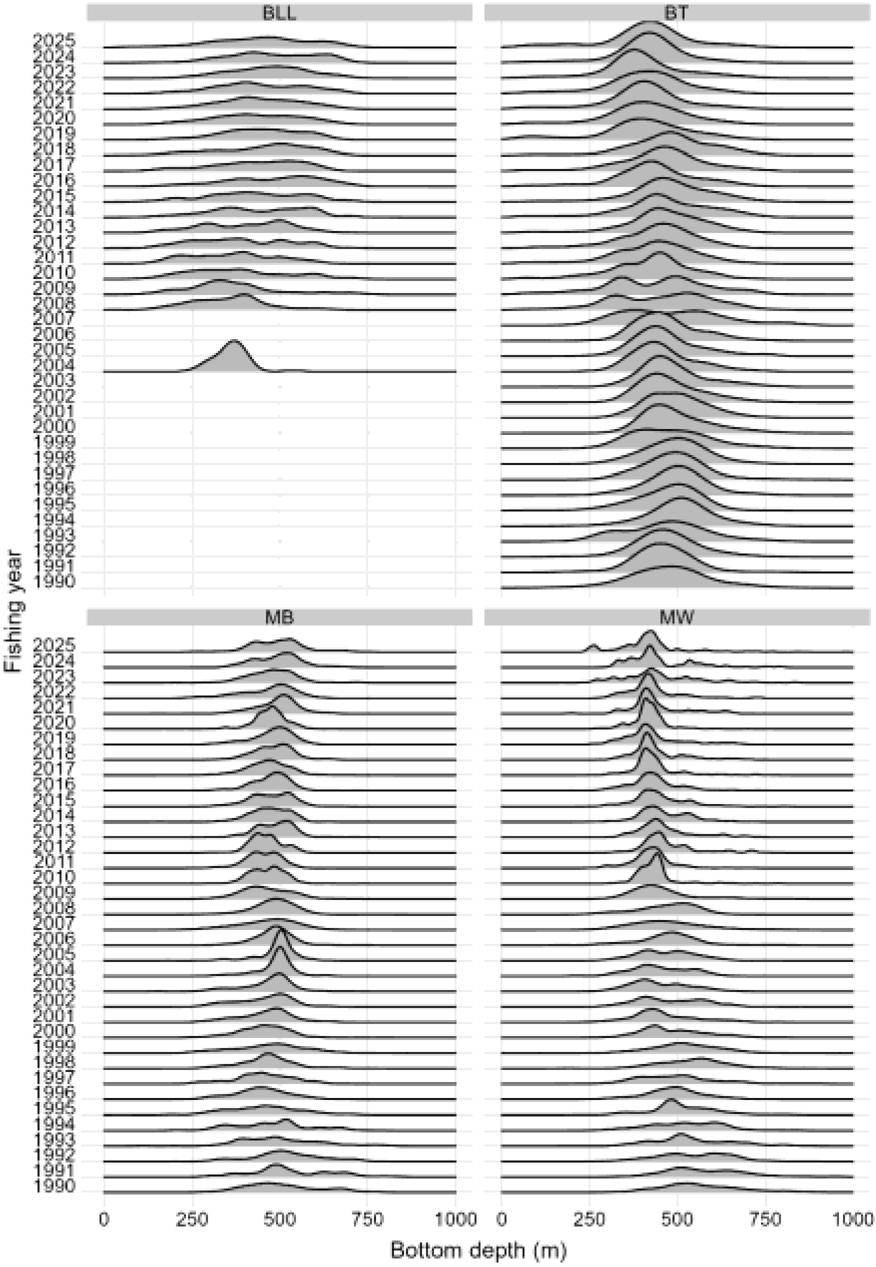


Figure A.8: Catch-weighted LIN 7WC distribution of bottom depth by fishing year for bottom longline (BLL), bottom trawl (BT), midwater trawl (MW), and midwater trawl within 5 m of the bottom (MB – code defined within the analysis above).

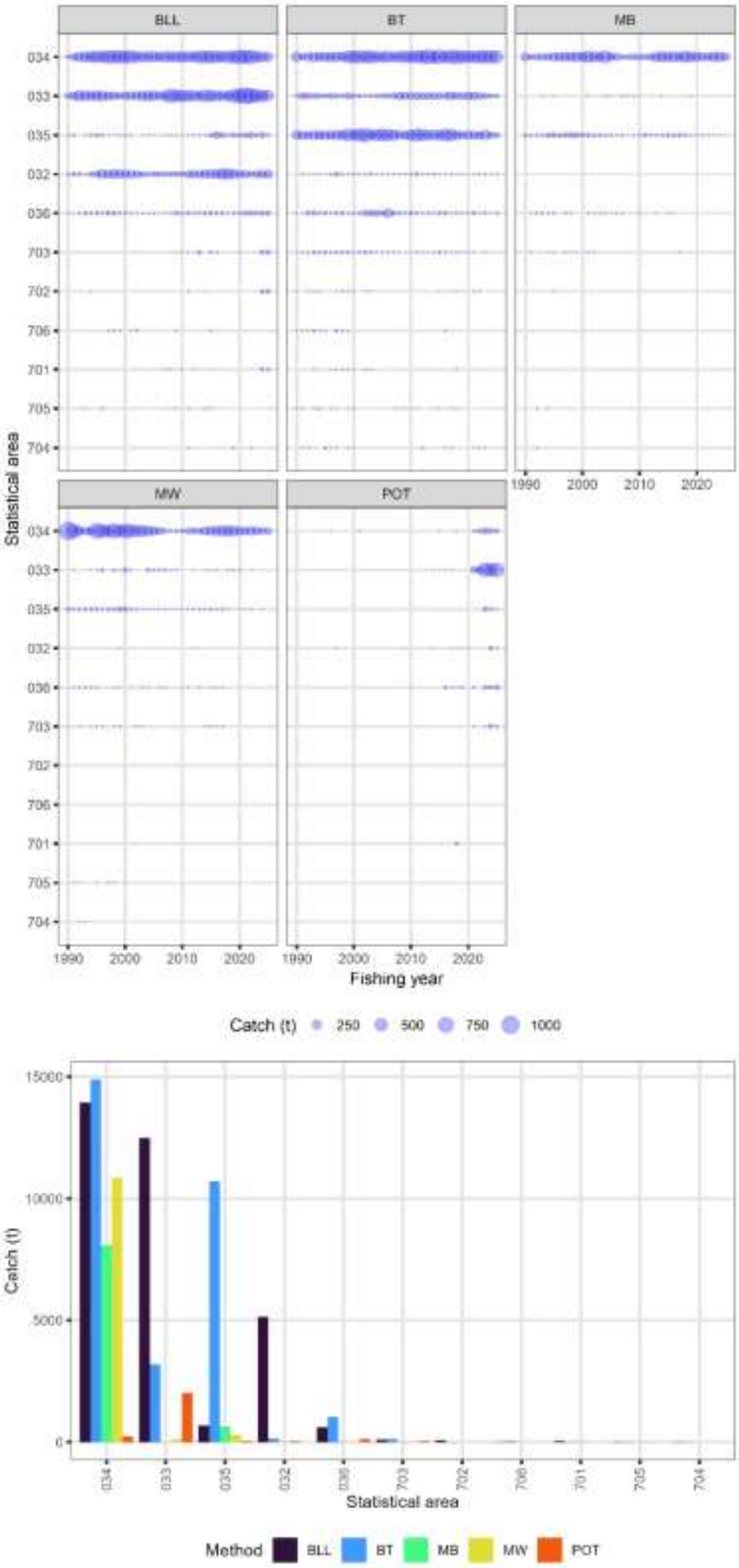


Figure A.9: LIN 7WC distribution of annual ling catch reported on catch and effort returns by statistical area for bottom longline (BLL), bottom trawl (BT), midwater trawl (MW), midwater trawl within 5 m of the bottom (MB – code defined within the analysis above), and all potting methods (POT – code defined within the analysis above).

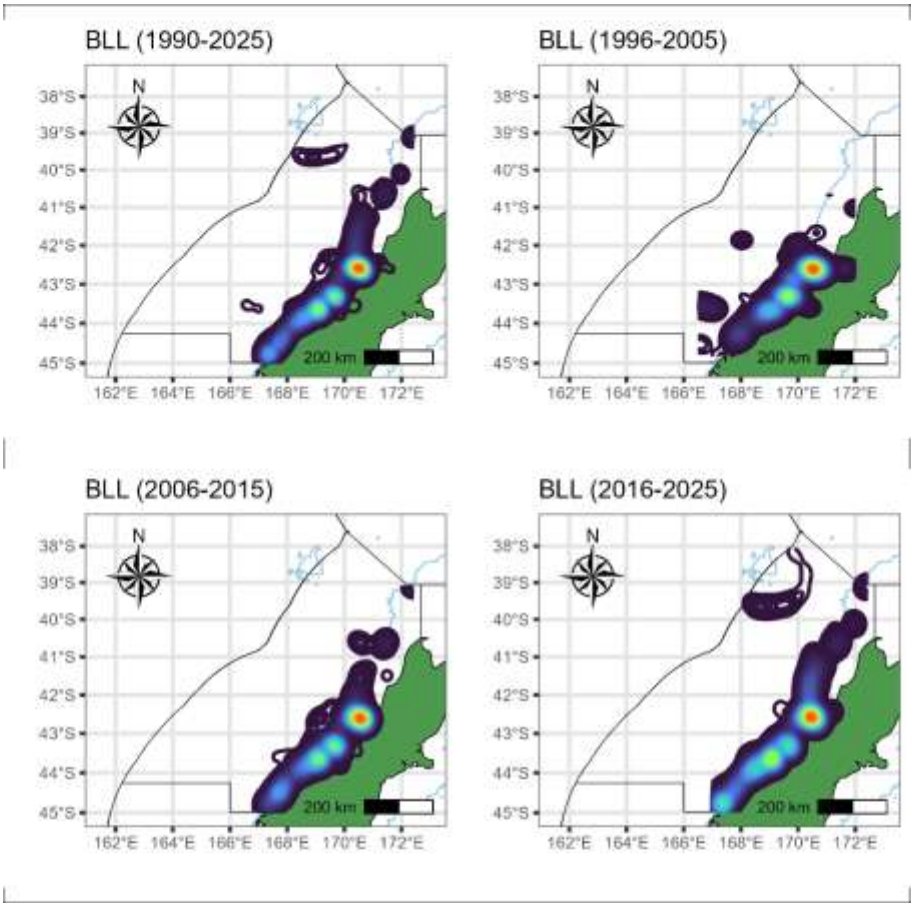


Figure A.10: Density distribution of ling catches in the LIN 7WC biological stock area by bottom longlines over time. Year ranges are fishing years. Over two-thirds of records prior to 2008 did not report locations.

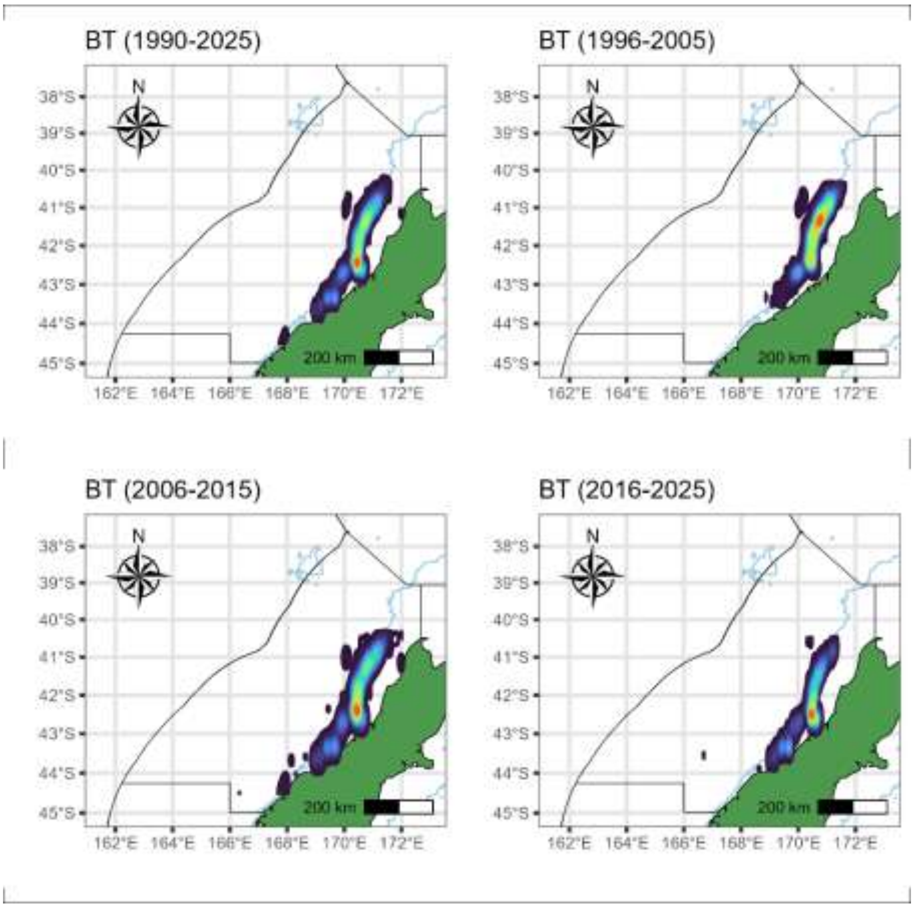
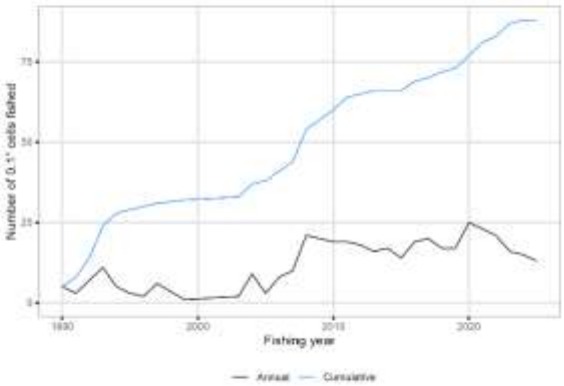
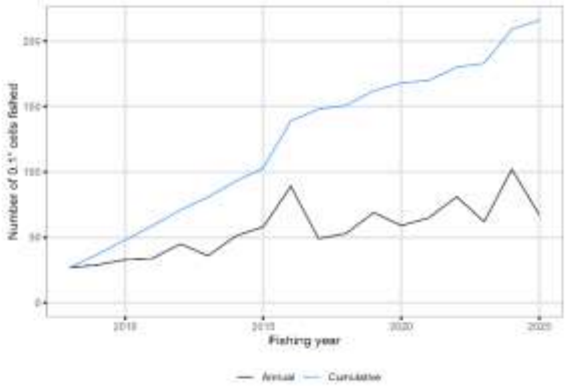


Figure A.11: Density distribution of ling catches in the LIN 7WC biological stock area by bottom trawls over time. Year ranges are fishing years.

Bottom trawl



Bottom longline



Potting

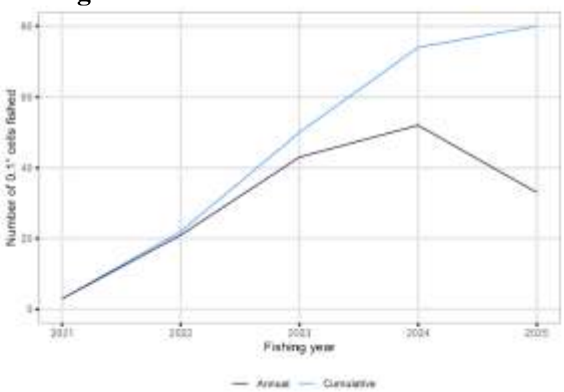


Figure A.12: Spatial distribution of the top 90 percentile catch of the ling target fishery in LIN 7WC: annual total number of cells of 0.1° latitude and longitude that were fished and cumulative number of new cells fished over time.

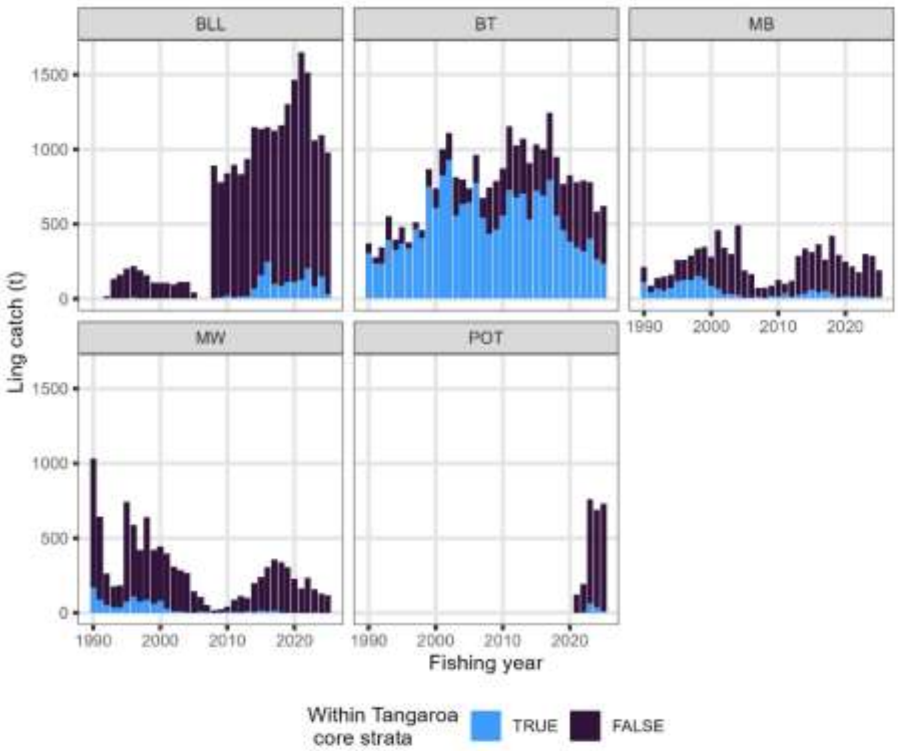


Figure A.13: LIN 7WC distribution of annual ling catch reported on catch and effort returns that fall within the *Tangaroa* survey core strata area for bottom longline (BLL), bottom trawl (BT), midwater trawl (MW), midwater trawl within 5 m of the bottom (MB – code defined within the analysis above), and all potting methods (POT – code defined within the analysis above).

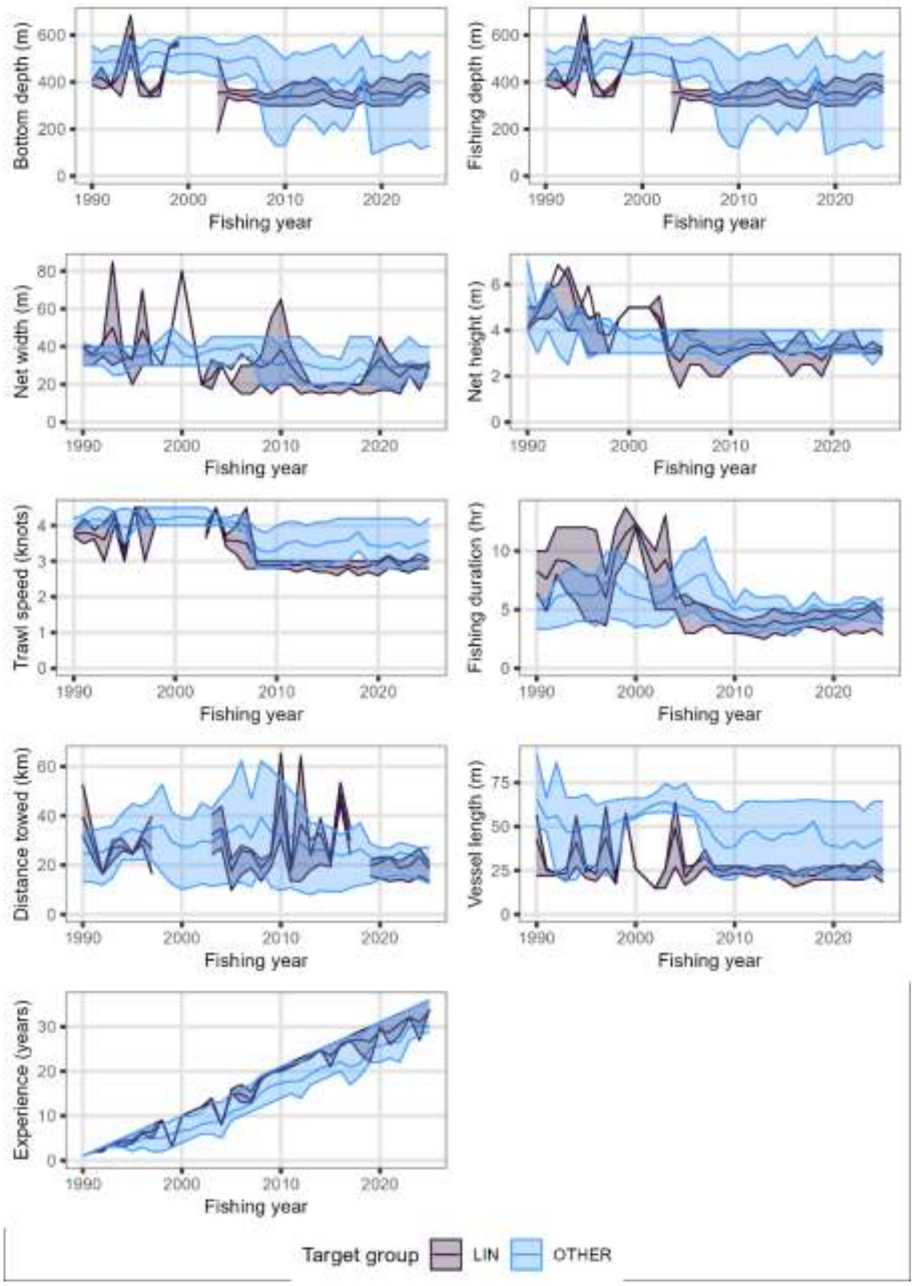
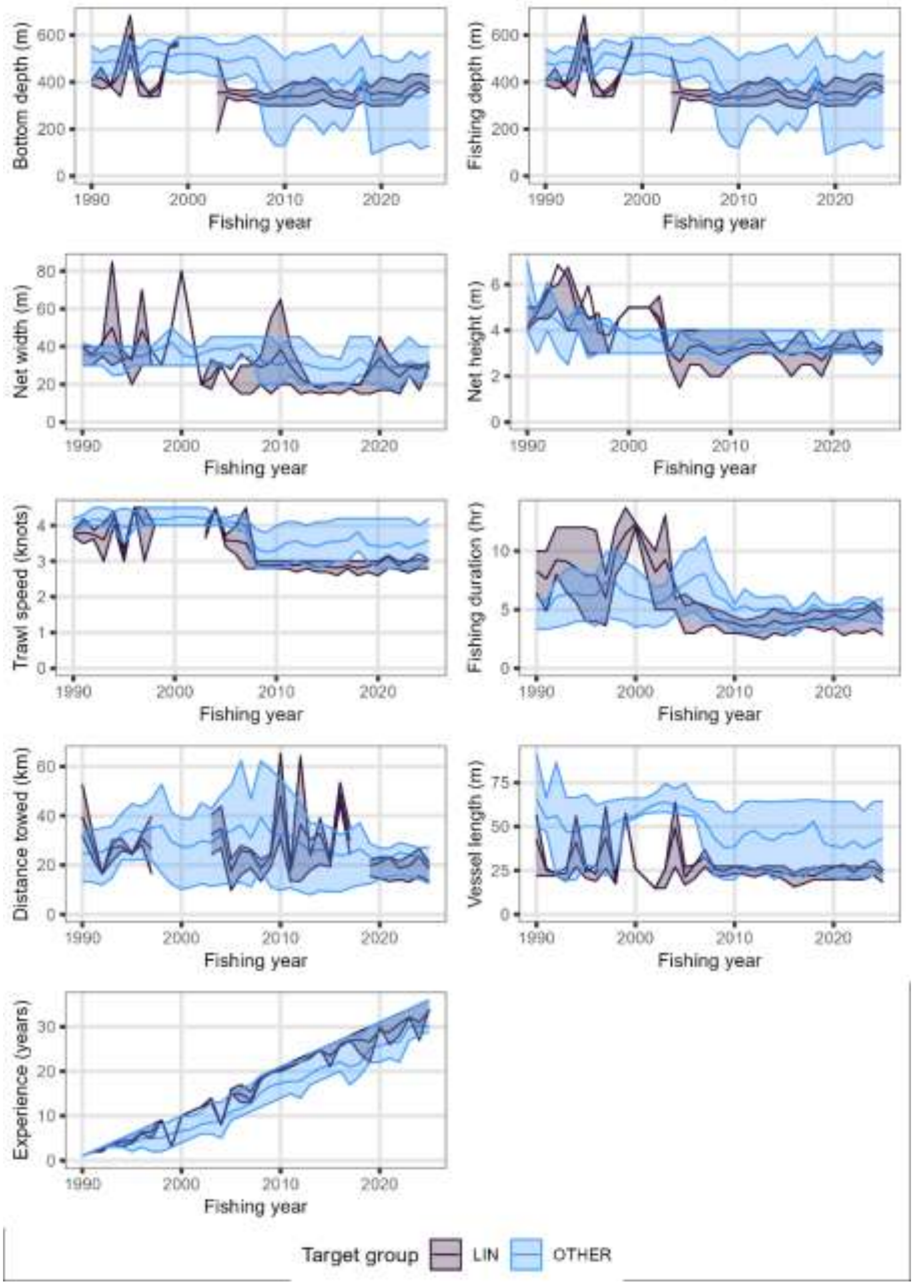


Figure A.14: Change in effort characteristics over time by target species of the bottom trawl ling fisheries in LIN 7WC. Median and interquartile range are shown.


Bottom depth (m)
Fishing depth (m)
Net width (m)
Net height (m)
Trawl speed (knots)
Fishing duration (hr)
Distance towed (km)
Vessel length (m)
Experience (years)
Fishing year
Target group
LIN
OTHER

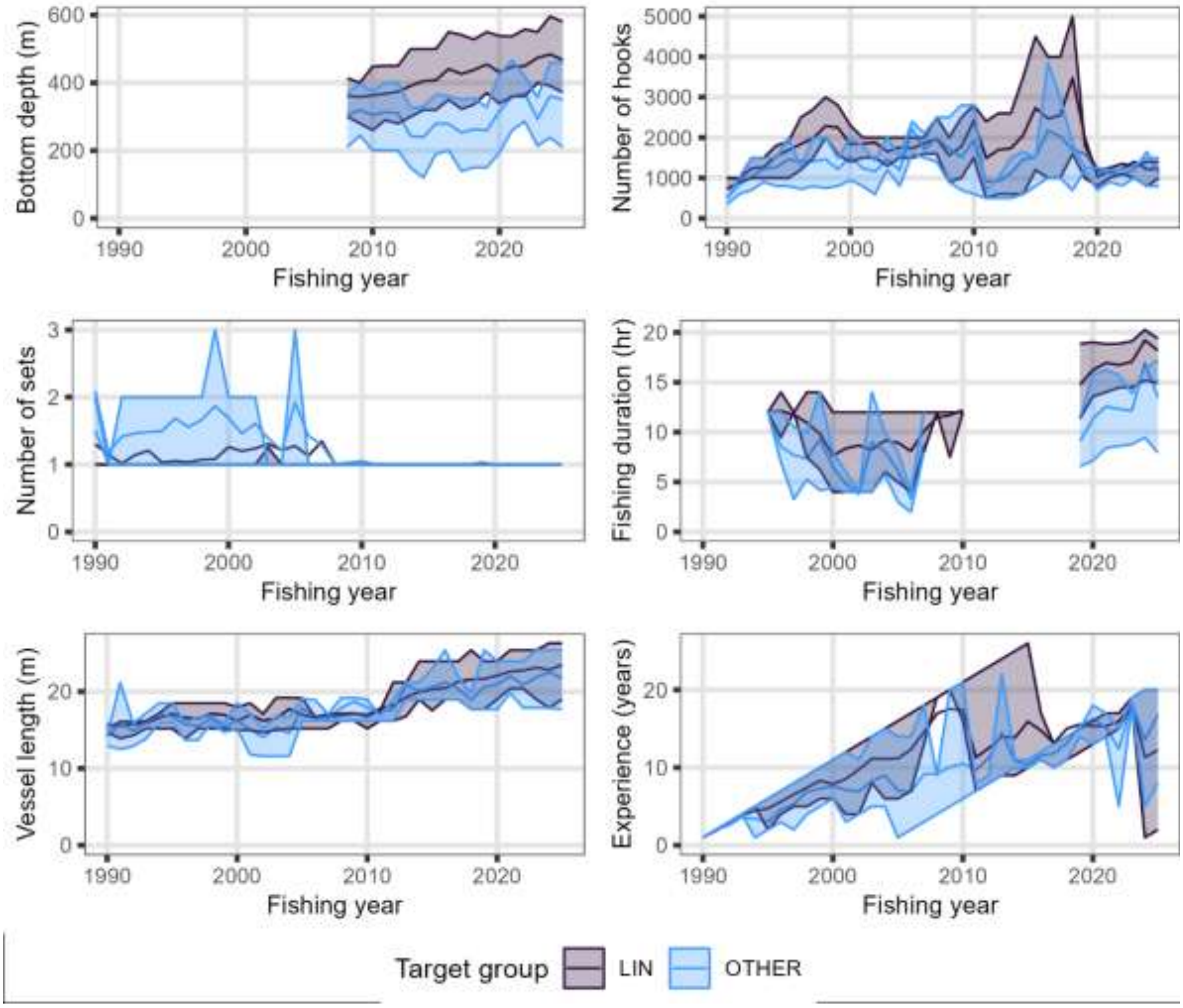


Figure A.15: Change in effort characteristics over time by target species of the longline ling fisheries in LIN 7WC. Median and interquartile range are shown.

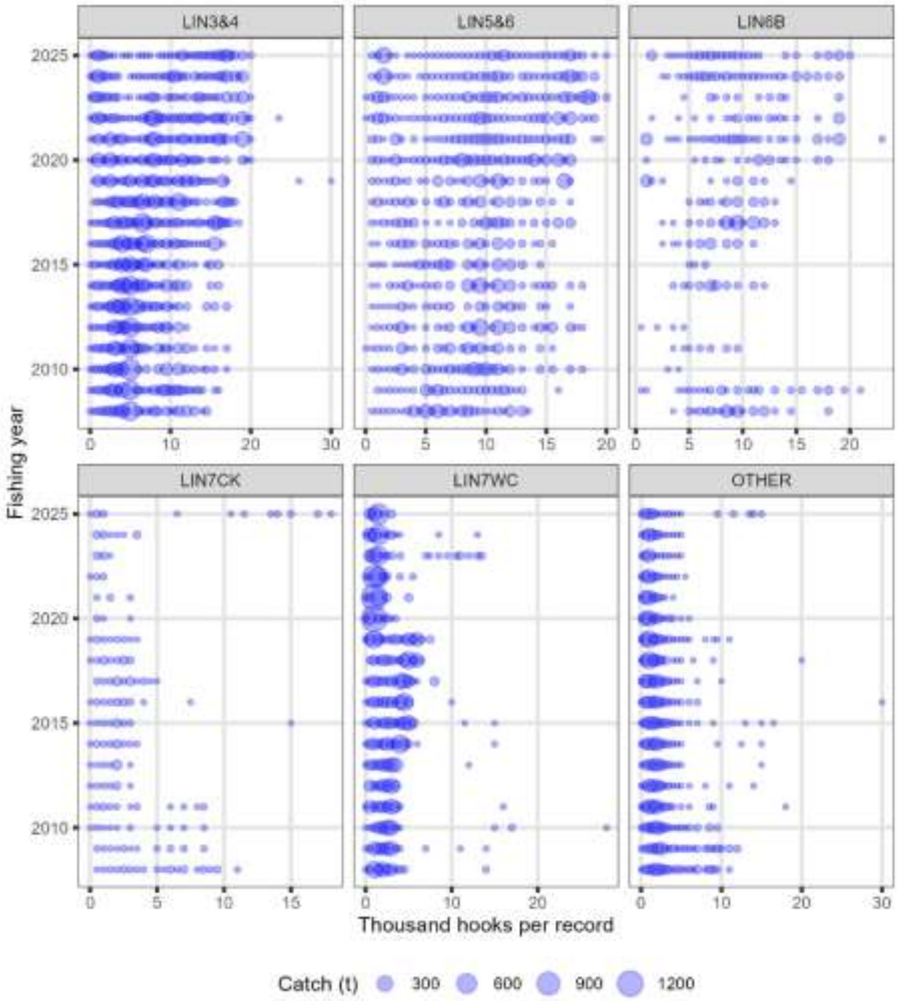


Figure A.16: Annual ling catch reported on catch and effort returns by the number of hooks for vessels per report (discretised in 500 hooks bins) and by year for each ling stock.

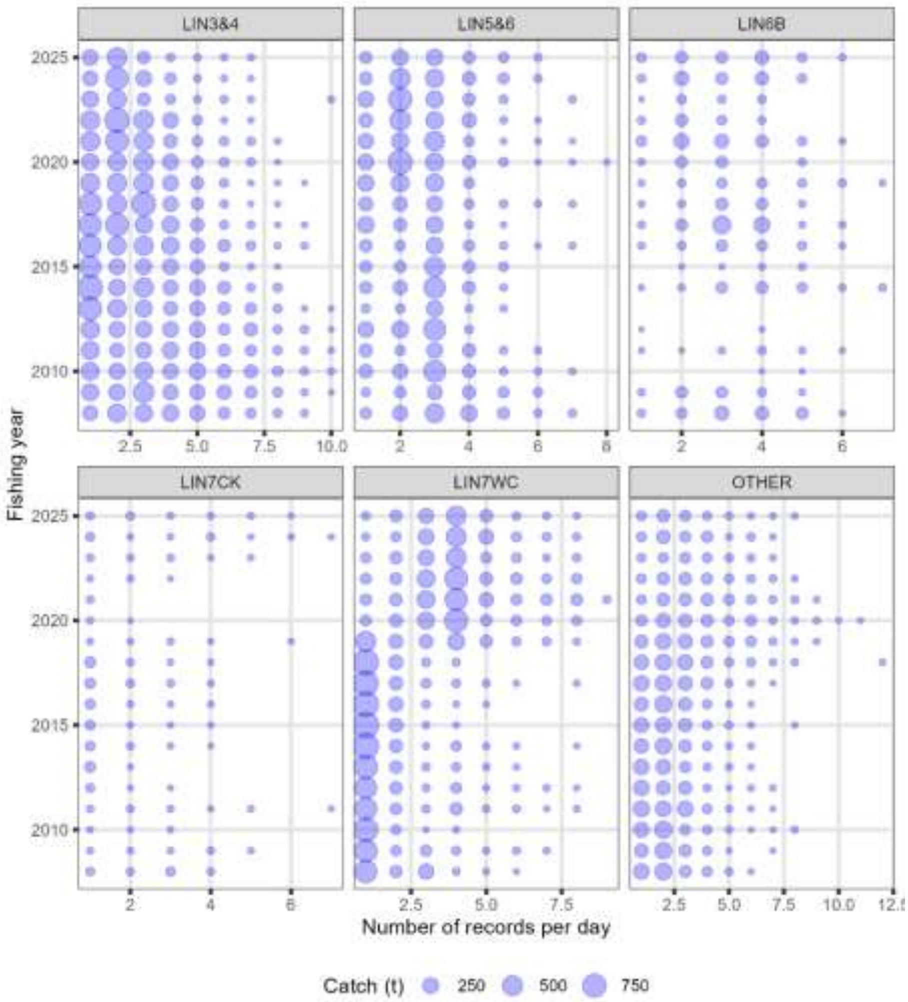


Figure A.17: Annual ling catch reported on catch and effort returns by the number of reports of vessels per day and by year for each ling stock.

13. APPENDIX B – AGE COMPOSITIONS

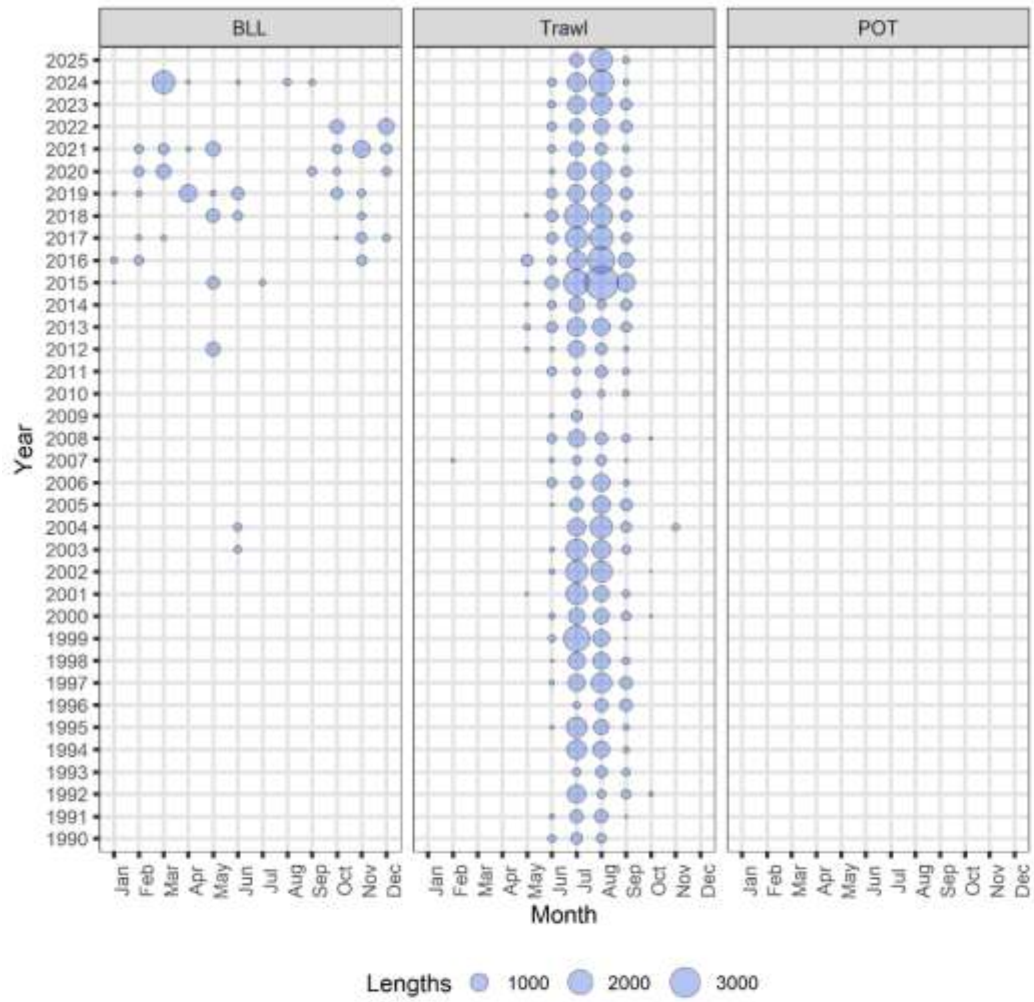


Figure B.1: LIN 7WC distribution of ling length measurements collected by observers for potting (POT), bottom longline (BLL) and bottom trawl (BT) gears by month and year sampled.

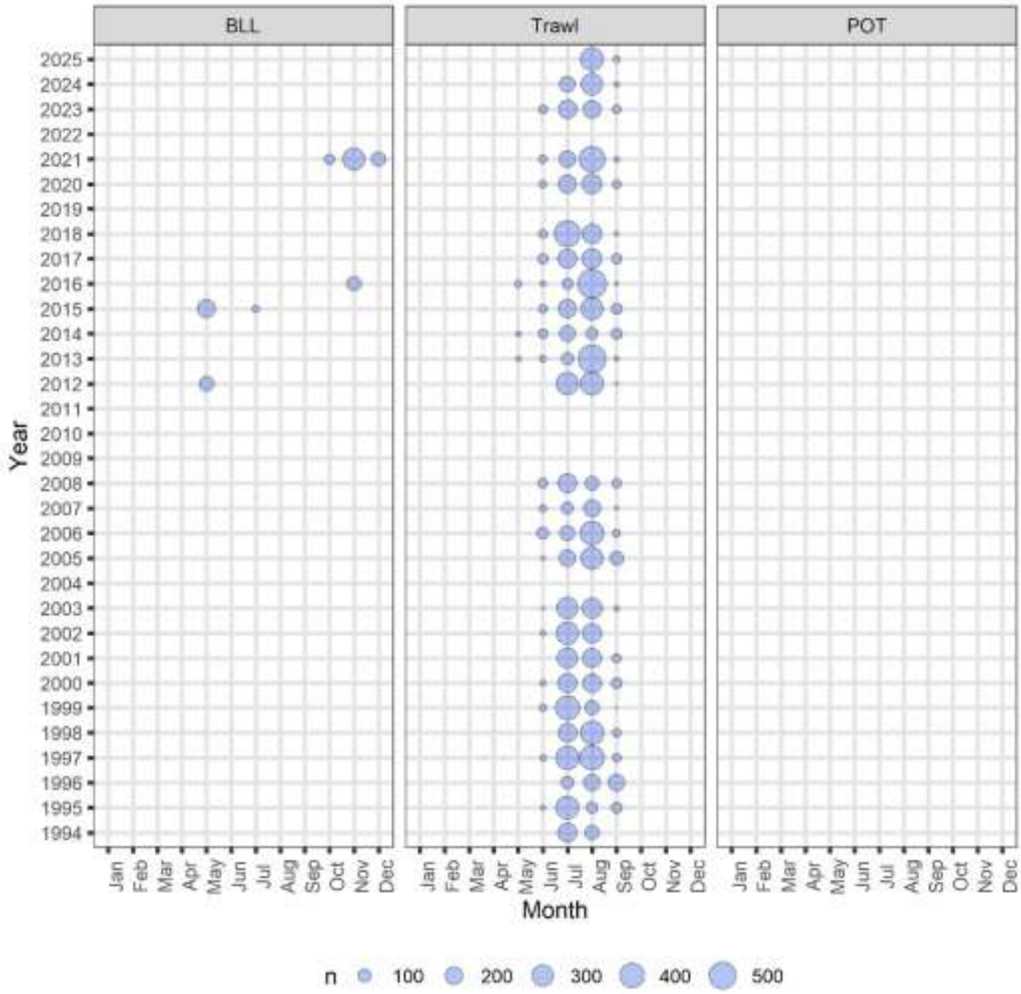


Figure B.2: LIN 7WC distribution of ling age data collected by observers for potting (POT), bottom longline (BLL) and bottom trawl (BT) gears by month and year sampled.

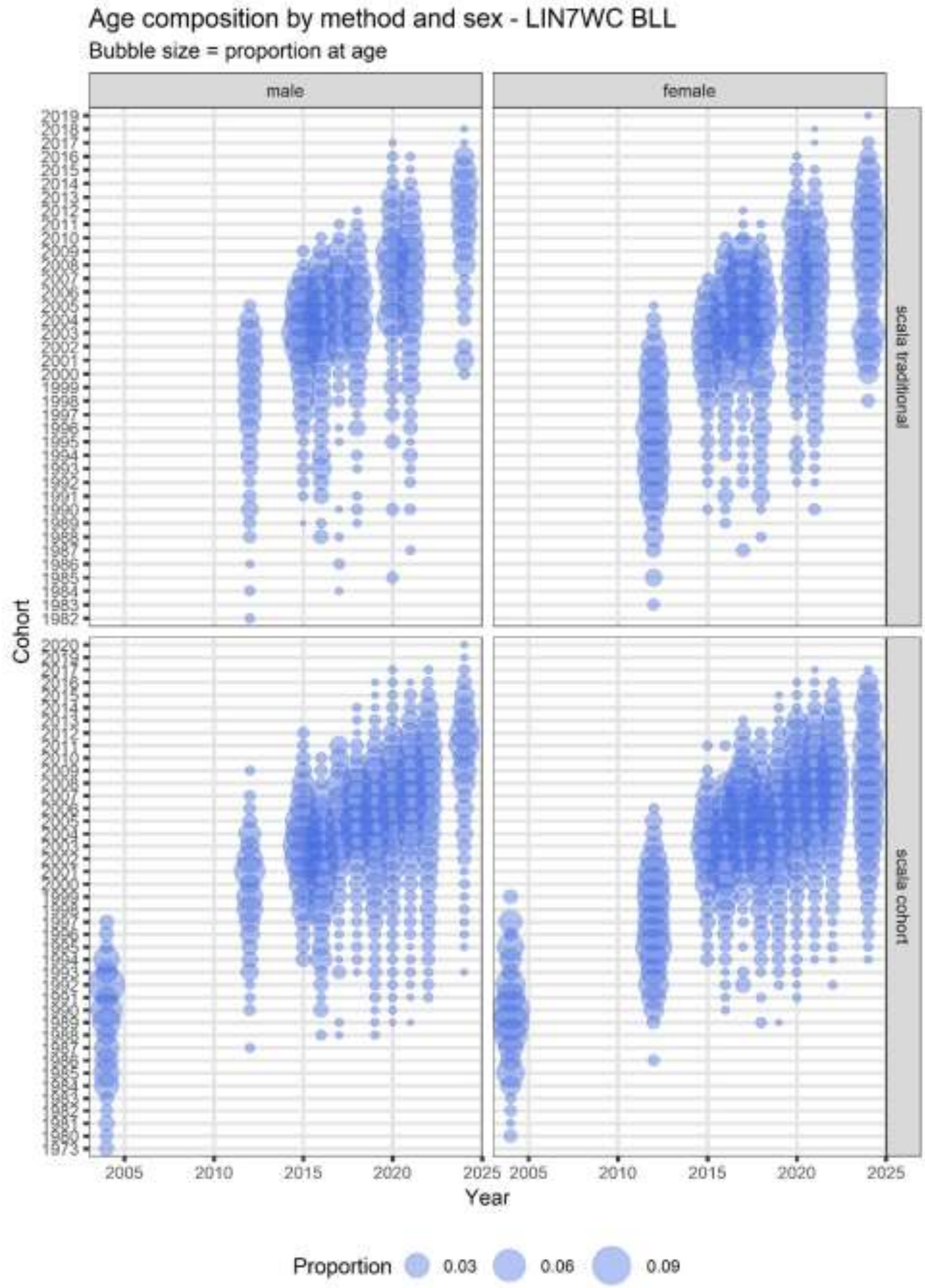


Figure B.3: Progression of year classes in the bottom trawl fishery scaled age compositions for the standard ALK method (top row) and the cohort model (bottom row) by sex (left = female, right = male).

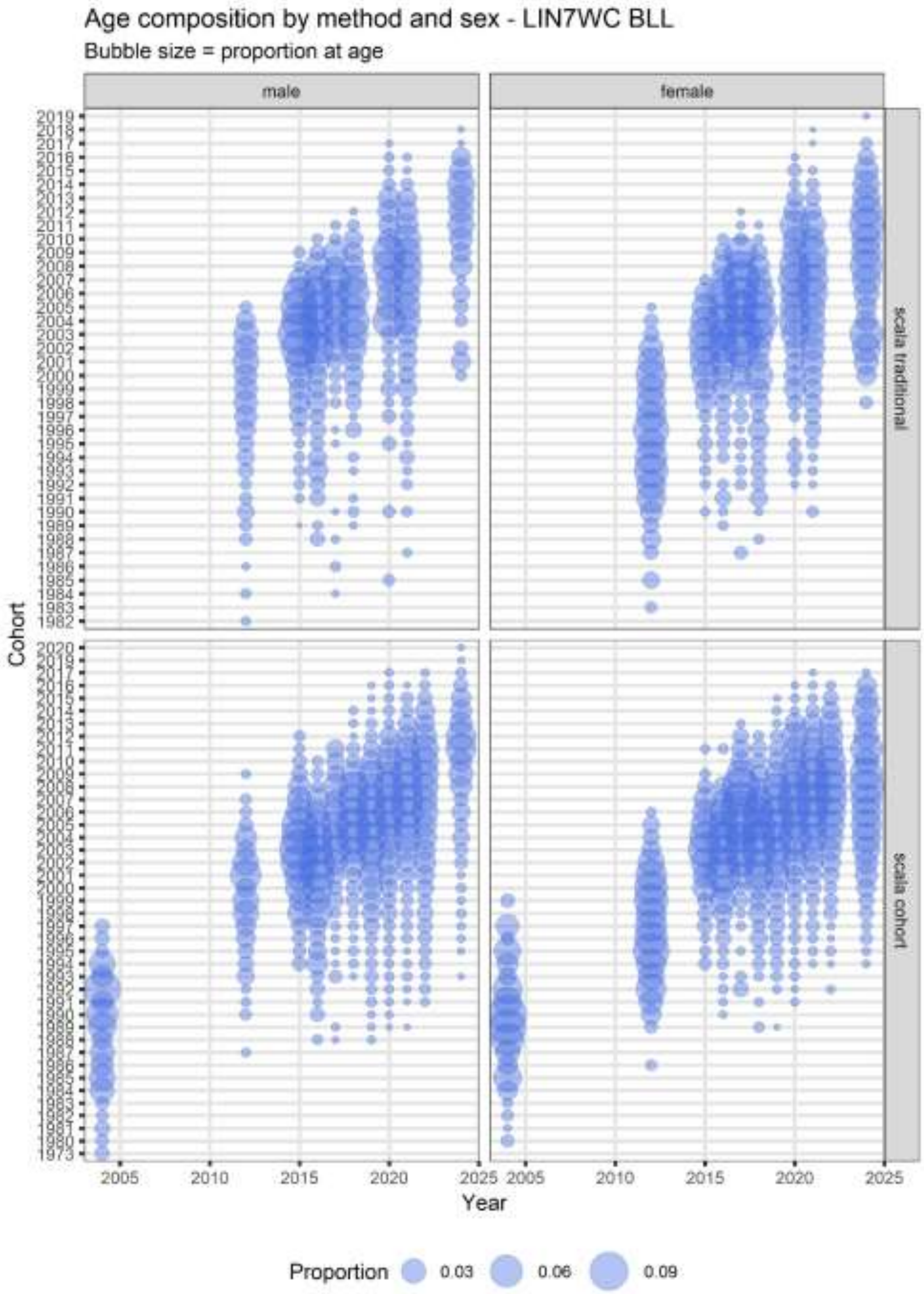


Figure B.4: Progression of year classes in the bottom longline fishery scaled age compositions for the standard ALK method (top row) and the cohort model (bottom row) by sex (left = female, right = male).

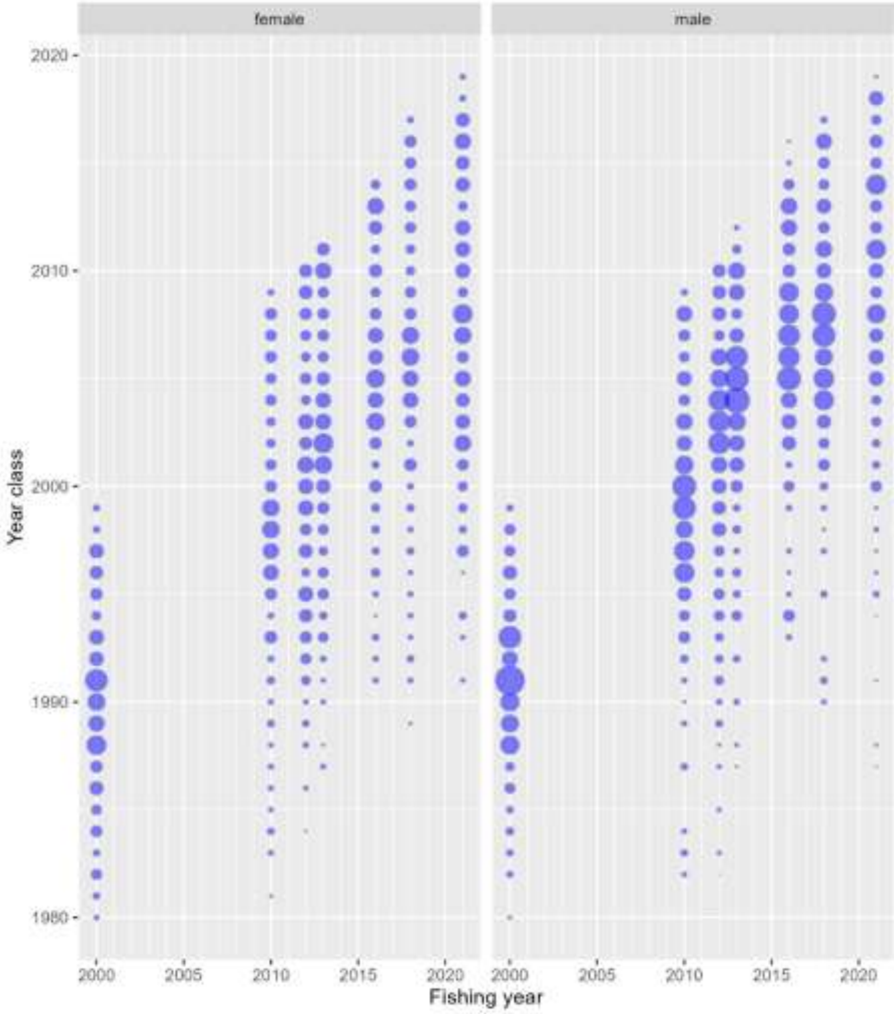


Figure B.5: Progression of year classes in the trawl survey scaled age frequencies.

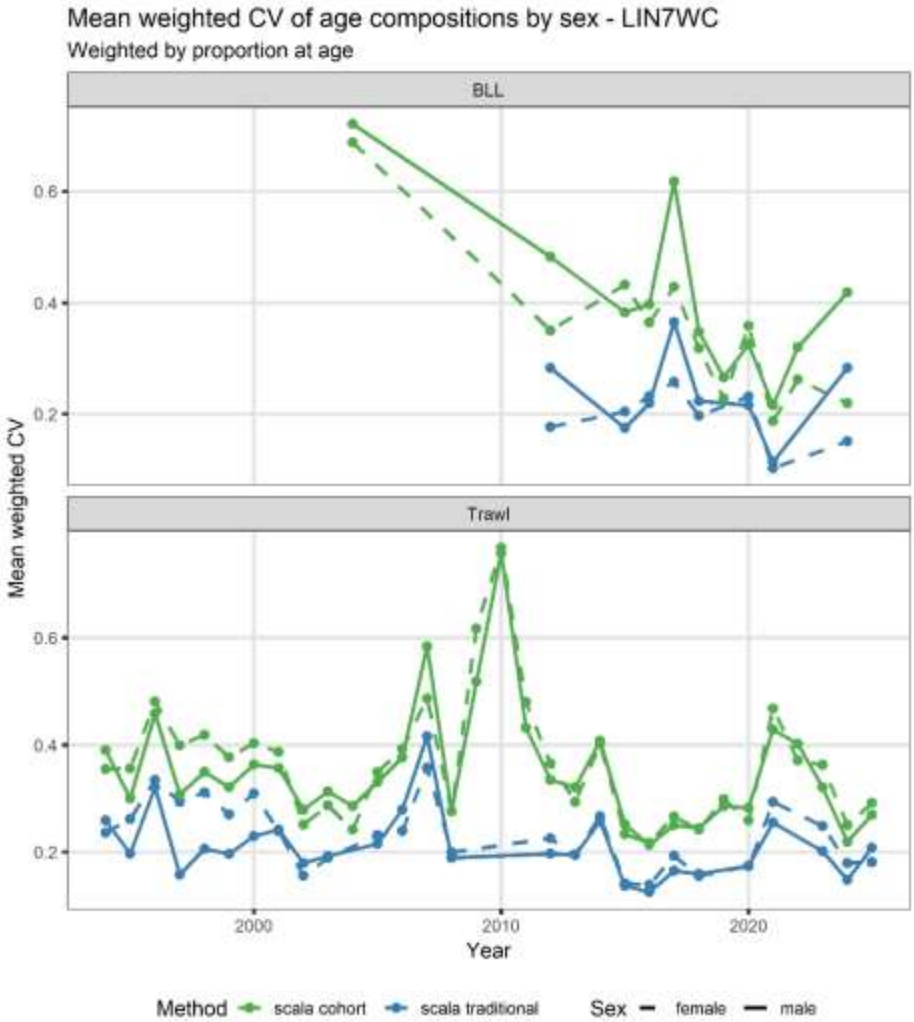


Figure B.6: Estimated mean weighted CV for female (dashed line) and male (solid line) for the age compositions from the standard ALK method (blue) and the cohort model (green) for BLL (top panel) and trawl (bottom panel) fisheries by year.

14. APPENDIX C – UPDATE OF BIOLOGICAL PARAMETERS

Table C.1: Length-weight parameters obtained in this analysis and compared with those reported by Horn (2005), Edwards (2017), and Mormede et al. (2023a).

Sex	Parameter	Horn (2005)	Edwards (2017)	Mormede et al. (2023)	This analysis
Male	*a*	0.00000115	0.00000135	0.00000131	0.00000133
	b	3.318	3.28	3.292	3.287
Female	*a*	0.93E-06	1.01E-6	0.98E-06	0.97E-06
	b	3.368	3.36	3.362	3.363

Table C.2: von Bertalanffy growth parameters obtained in this analysis (maximum likelihood estimator – MLE or Bayesian method) and compared to those reported by Horn (2005), Edwards (2017), and Mormede et al. (2023a).

Sex	Paramete r	Horn (2005)	Horn (2022)	Edwards (2017)	Mormede et al. (2023)	This analysis MLE	This analysis Bayesian
Male	L_{inf}	159.9	134.4	141.00	140.0	133.9	126.1
	k	0.067	0.116	0.09	0.090	0.106	0.13
	t_o	-2.37	-0.1	-1.18	-1.08	-0.918	-0.1
Female	L_{inf}	169.3	157.7	164.15	164.1	158.5	148.9
	k	0.078	0.098	0.08	0.080	0.088	0.11
	t_o	-0.87	-0.1	-0.75	-0.86	-0.807	-0.1
Both	CV	–			0.08	0.09	0.09

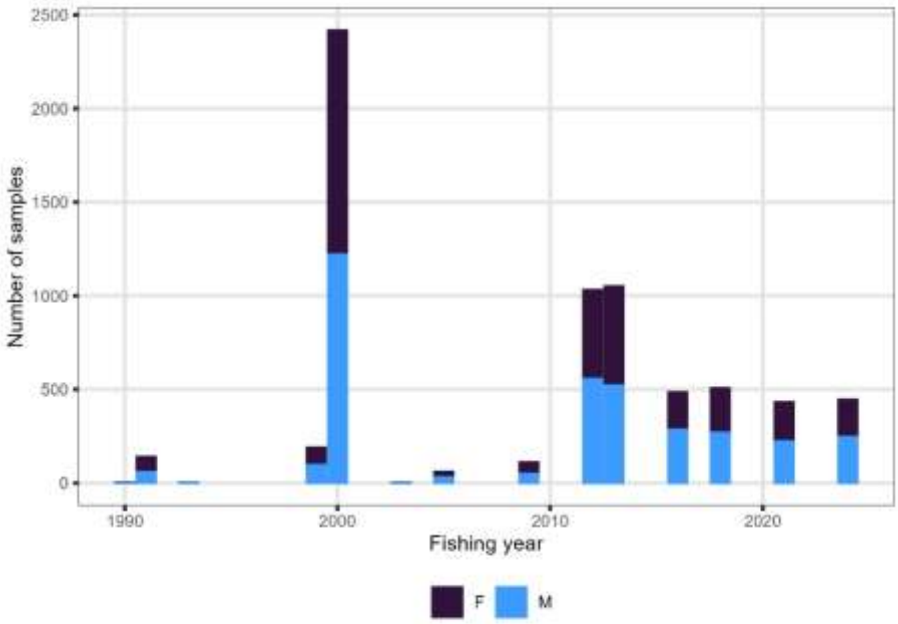


Figure C.1: Number of length-weight samples available by fishing year.

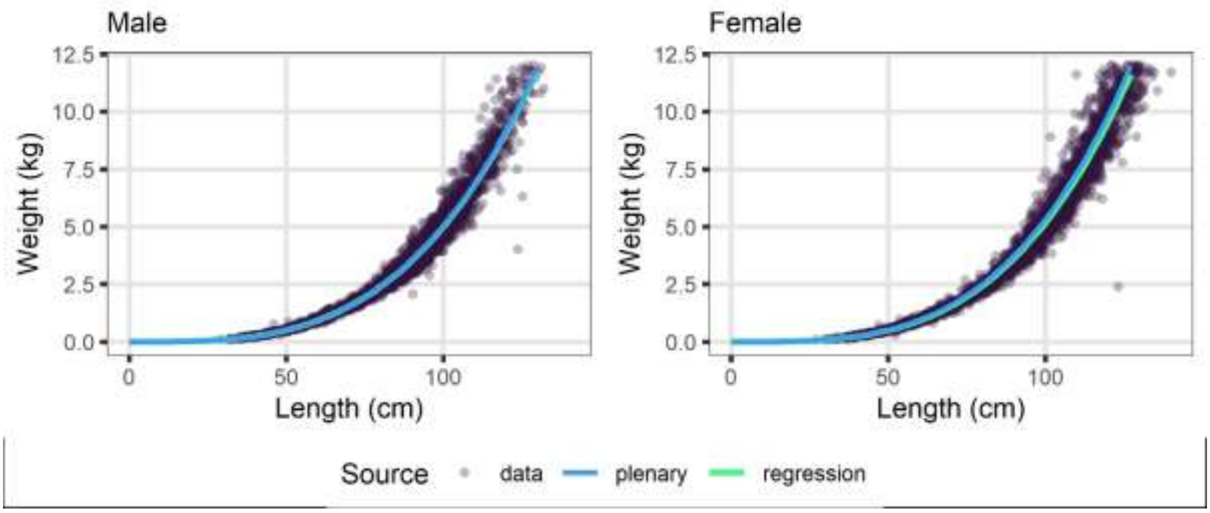
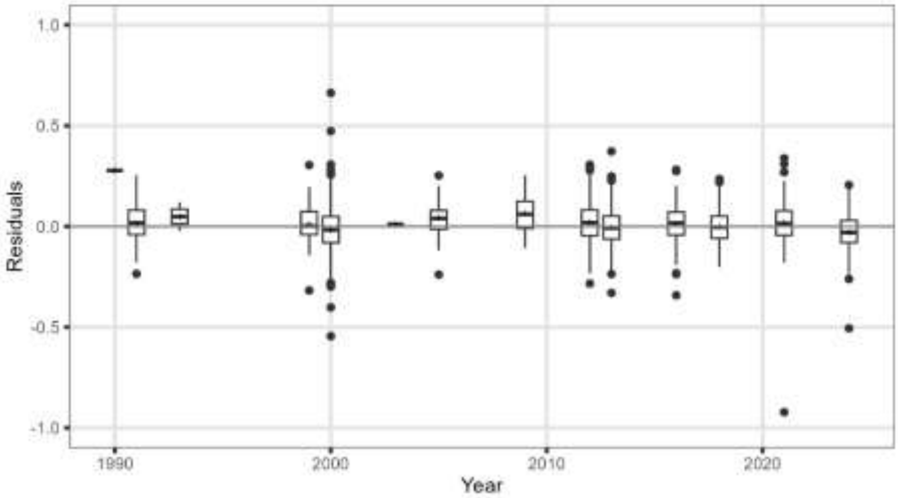


Figure C.2: Estimated length-weight relationships: the blue line represents the estimate reported in the plenary document (Fisheries New Zealand 2026) and used in the previous assessment (Mormede et al. 2024e), the green line is the estimated relationship from this analysis, and dots are the data points used.

Males



Females

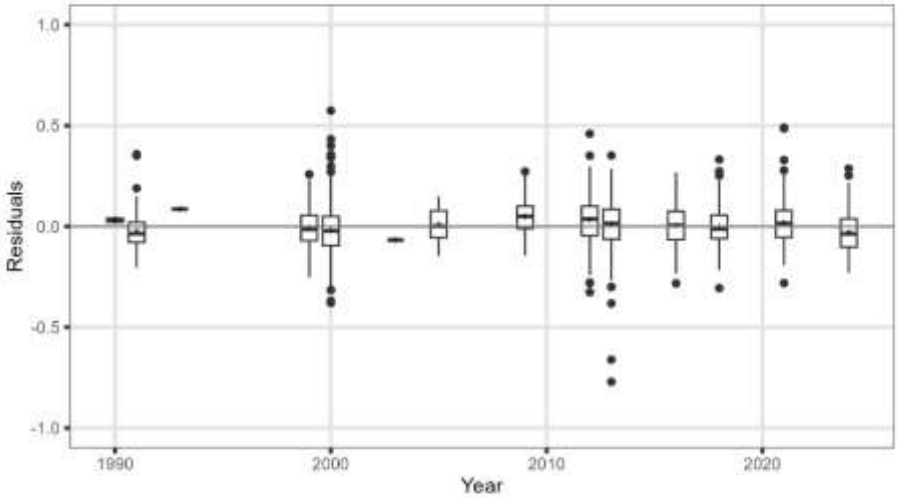


Figure C.3: Residuals by fishing year of the length-weight relationship for males (top) and females (bottom).

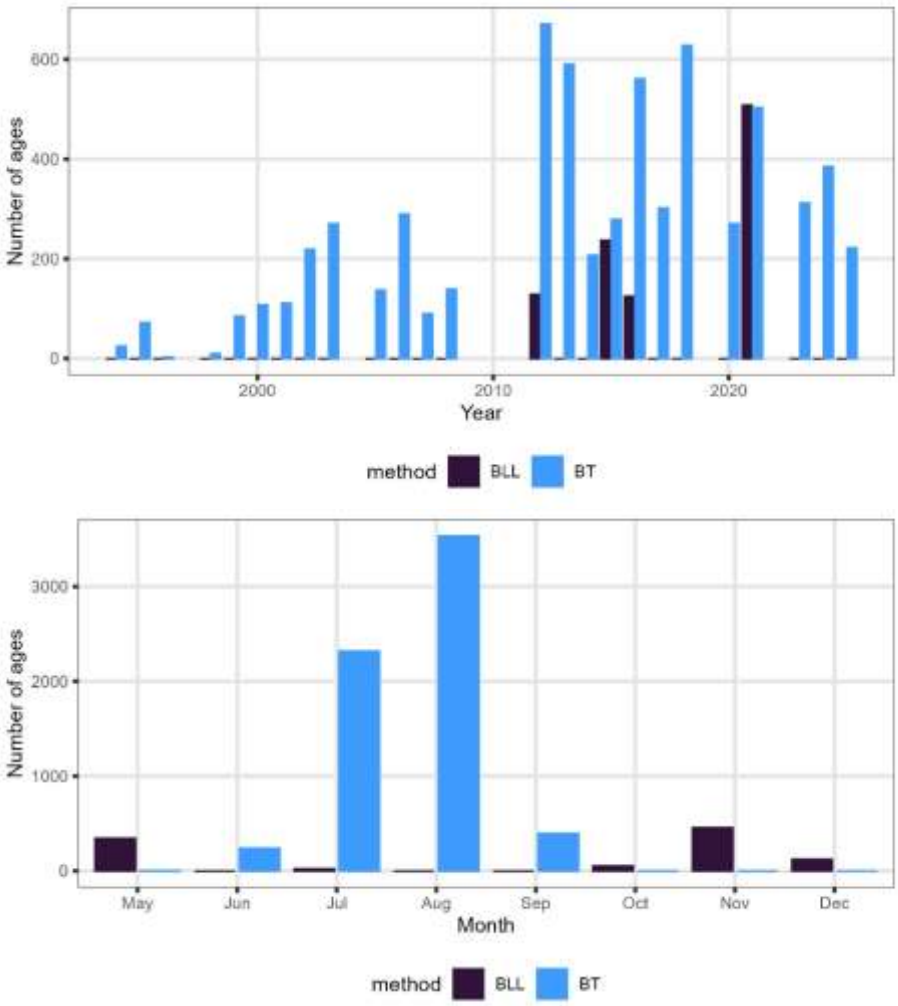


Figure C.4: Available age data, by calendar year (top) and by calendar month over all years (bottom) by method (bottom longline – BLL and bottom trawl - BT).

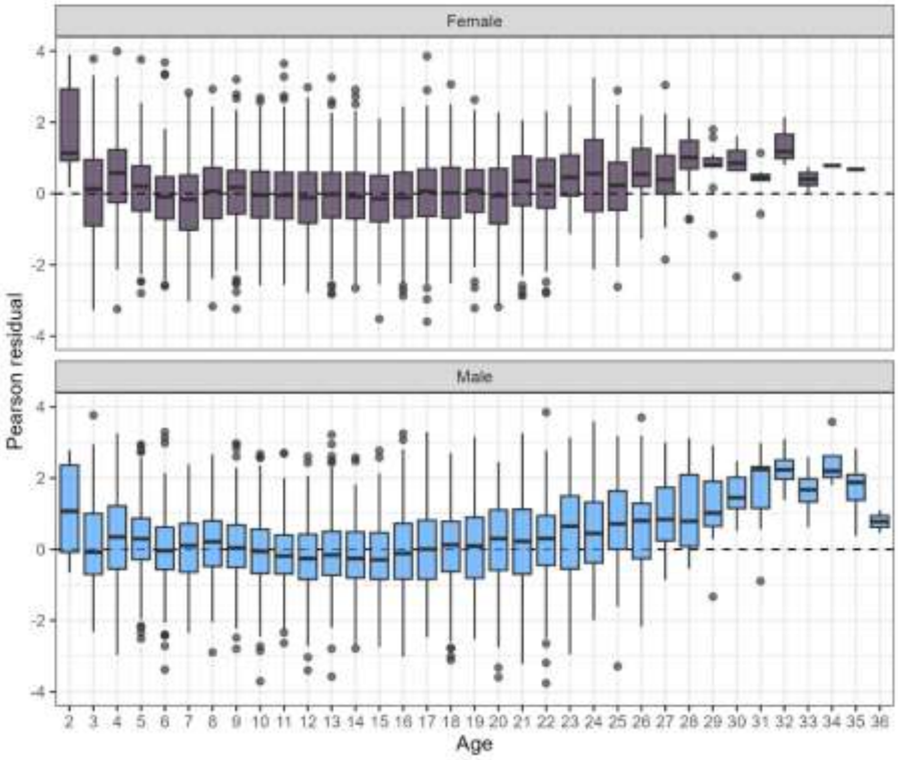


Figure C.5: Residuals of the maximum likelihood estimates for the von Bertalanffy Bayesian models by age.

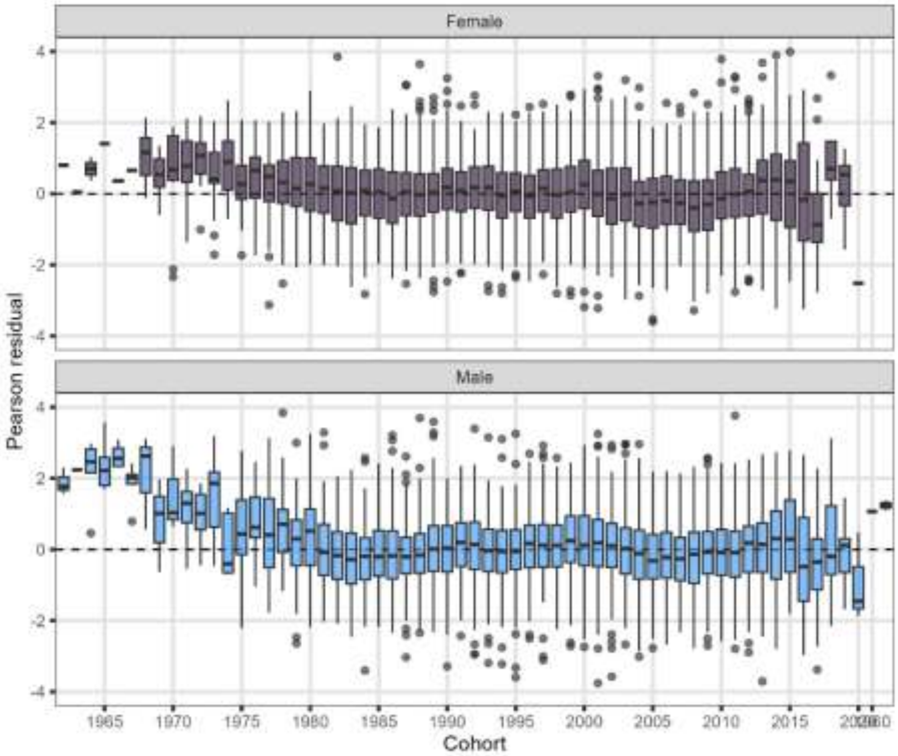


Figure C.6: Residuals of the maximum likelihood estimates for the von Bertalanffy Bayesian models by cohort (top) or by calendar year (bottom).

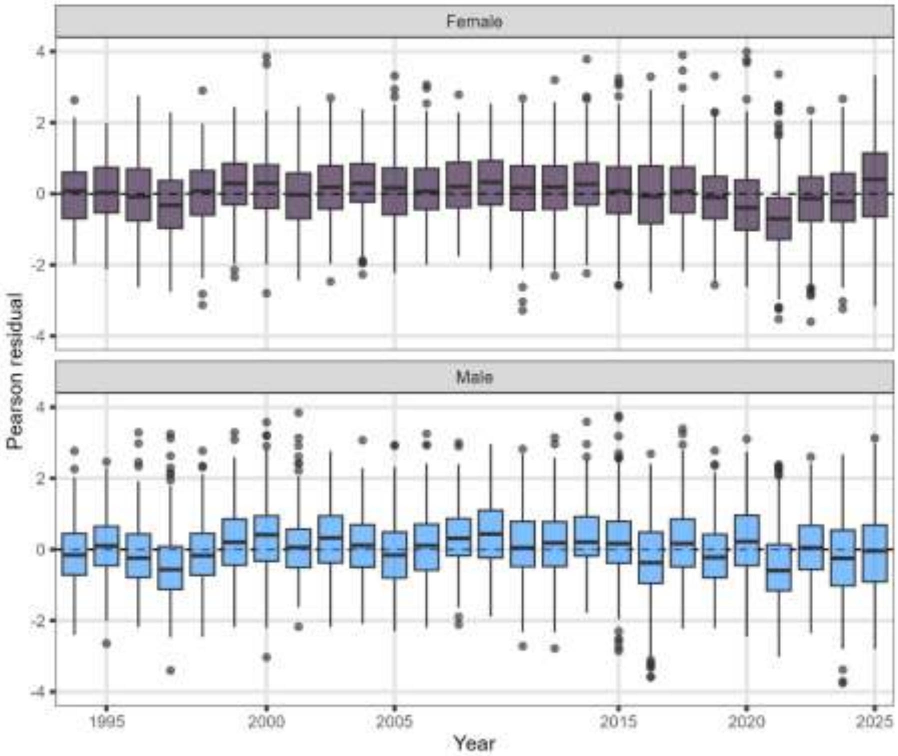


Figure C.7: Residuals of the maximum likelihood estimates of length at age for the von Bertalanffy Bayesian models by calendar year.

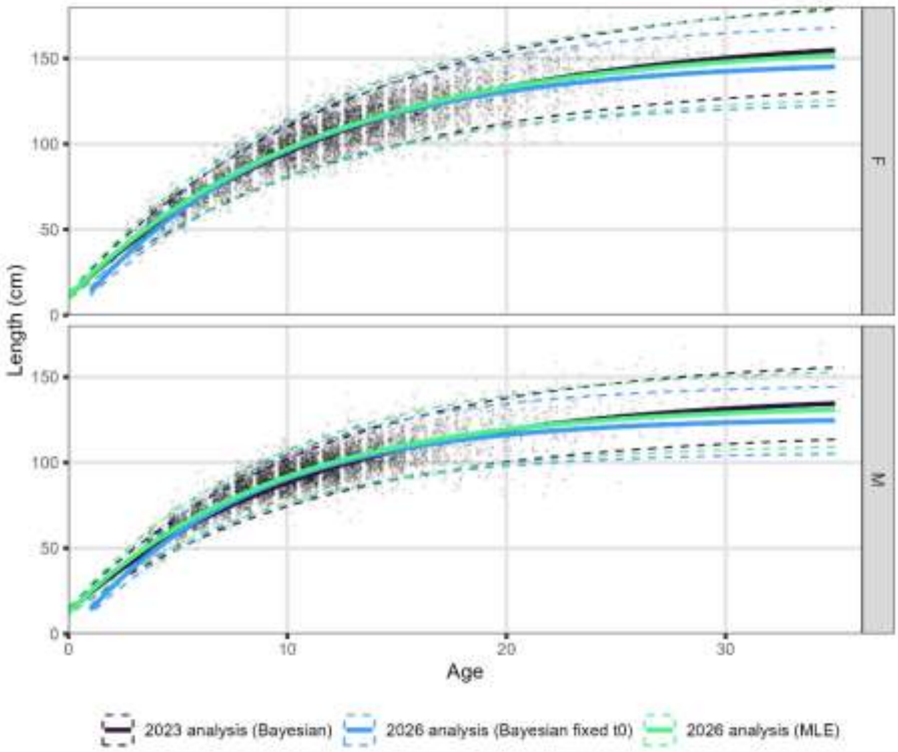


Figure C.8: Comparison of the maximum likelihood estimate of length at age for the von Bertalanffy MLE and Bayesian models with the estimates from the 2023 analysis (Mormede et al. 2023a).

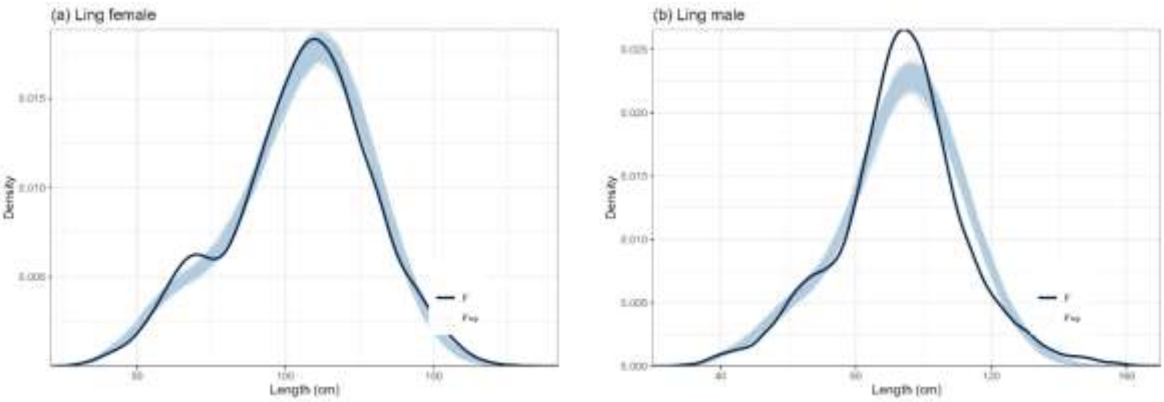


Figure C.9: Comparison of the empirical distribution of the data (y) to the posterior predictive distributions of simulated data (y_{rep}) from the Bayesian mean length at age growth model by sex.

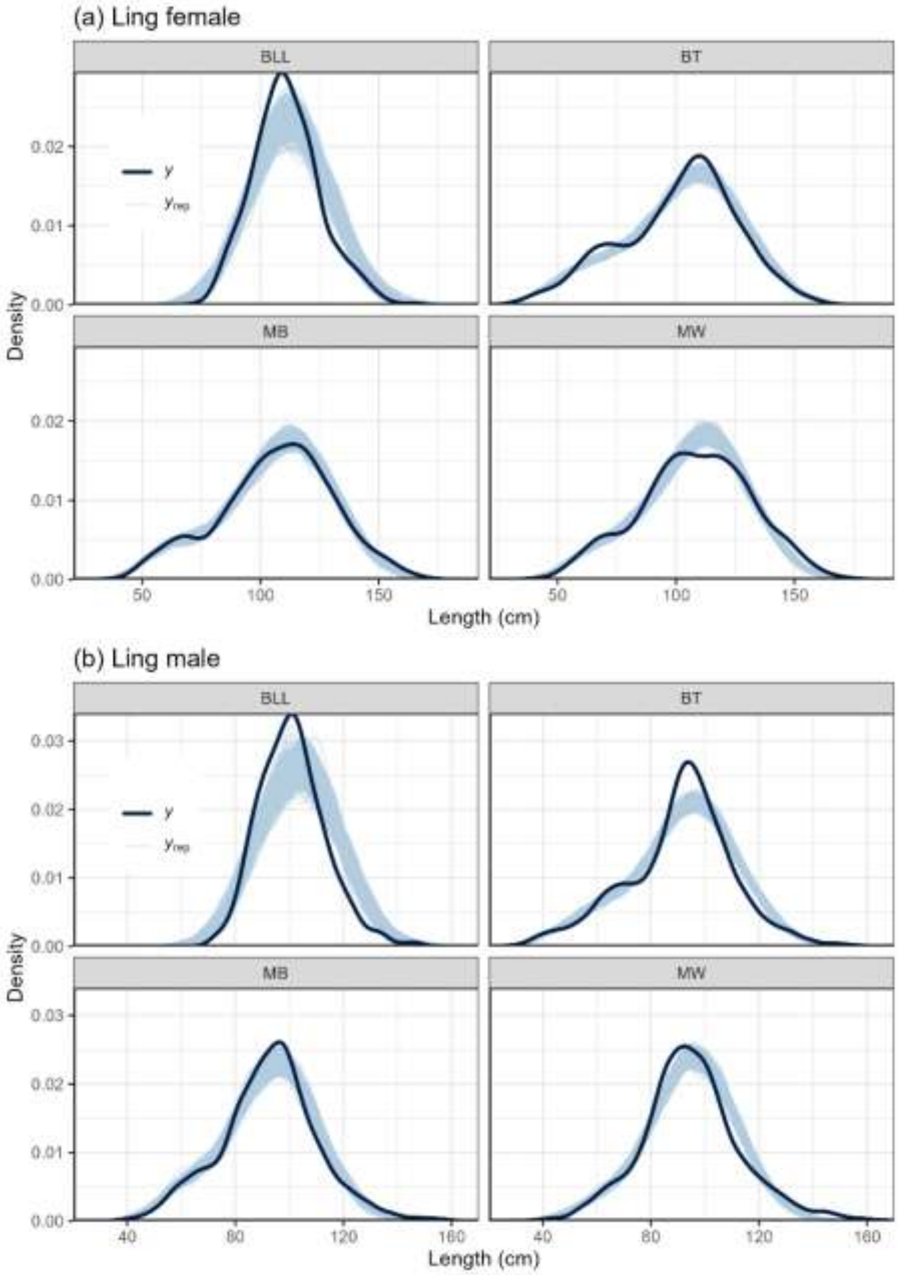


Figure C.10: Comparison of the empirical distribution of the data (*y*) to the posterior predictive distributions of simulated data (y_{rep}) from the Bayesian mean length at age growth model by sex and method.

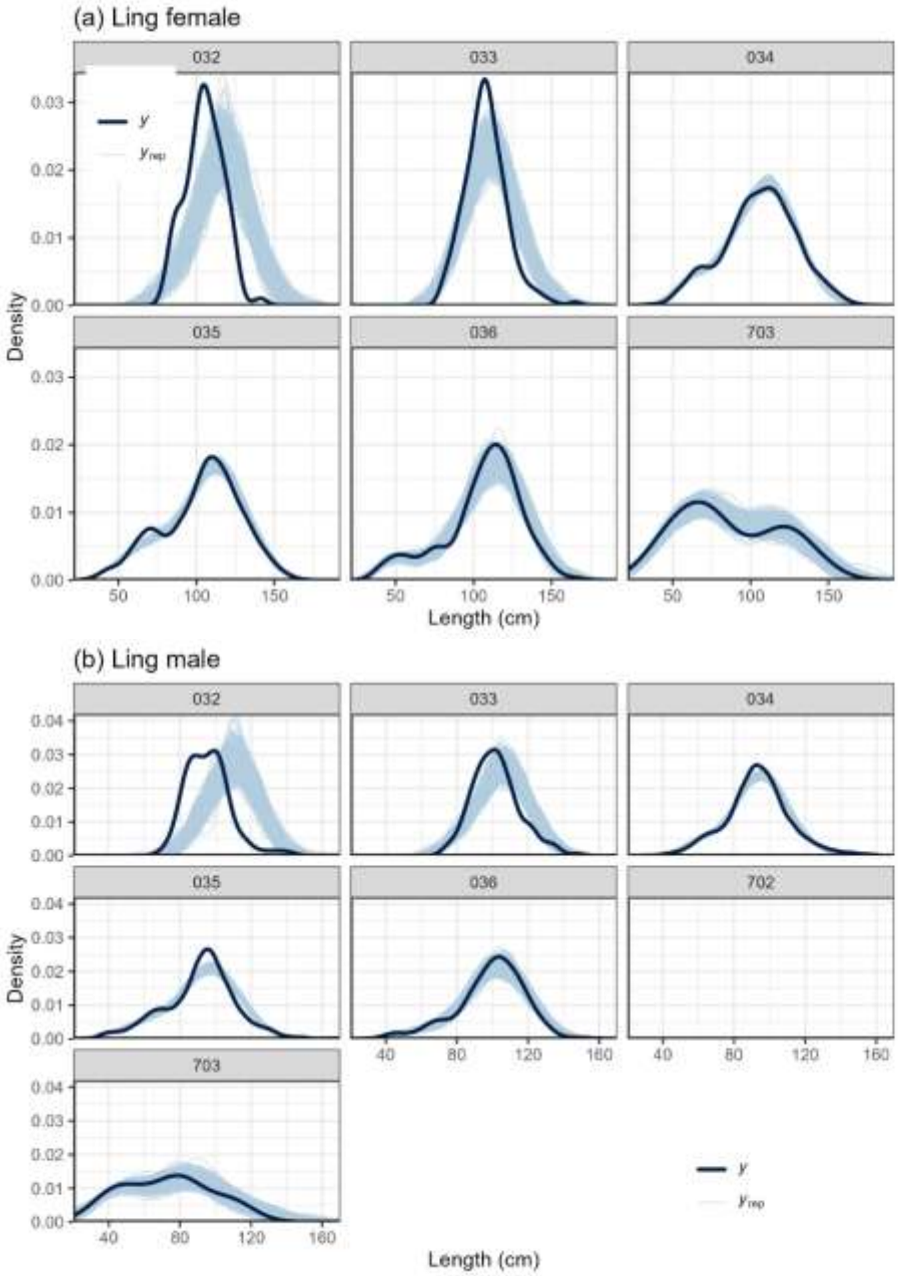


Figure C.11: Comparison of the empirical distribution of the data (*y*) to the posterior predictive distributions of simulated data (y_{rep}) from the Bayesian mean length at age growth model by sex and statistical area.

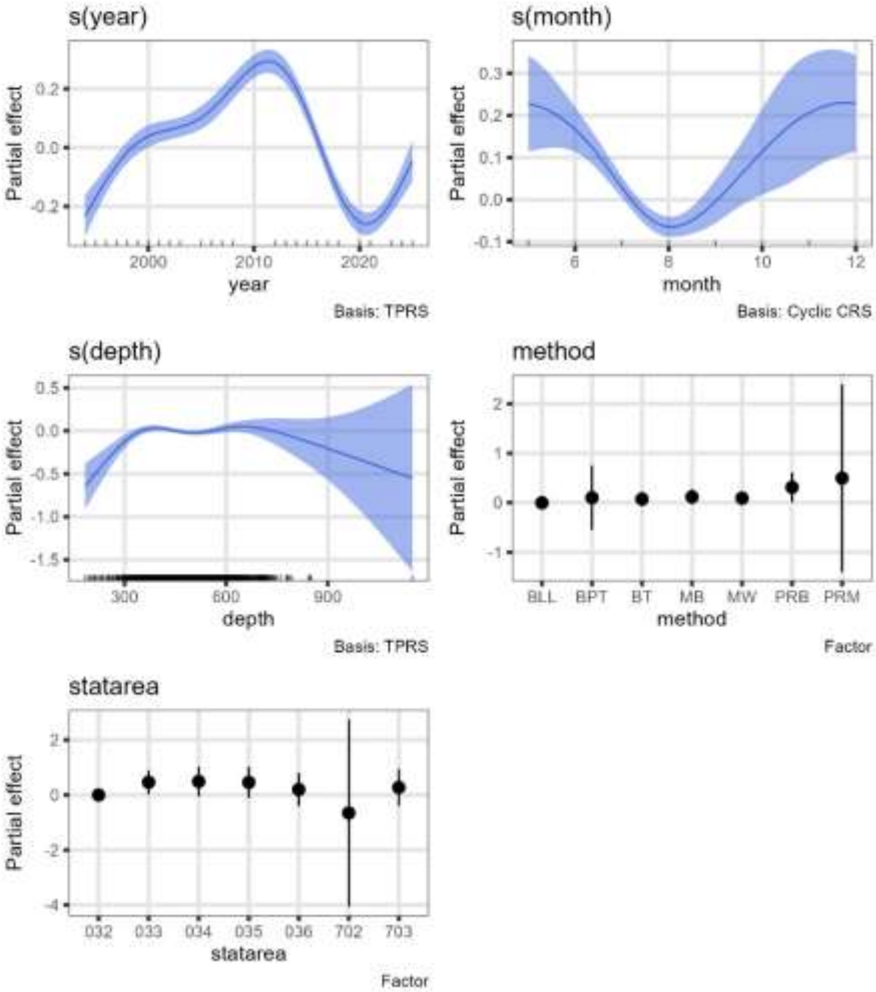


Figure C.12: Partial effects plots of the GAM model of residuals of the Bayesian von Bertalanffy growth model.

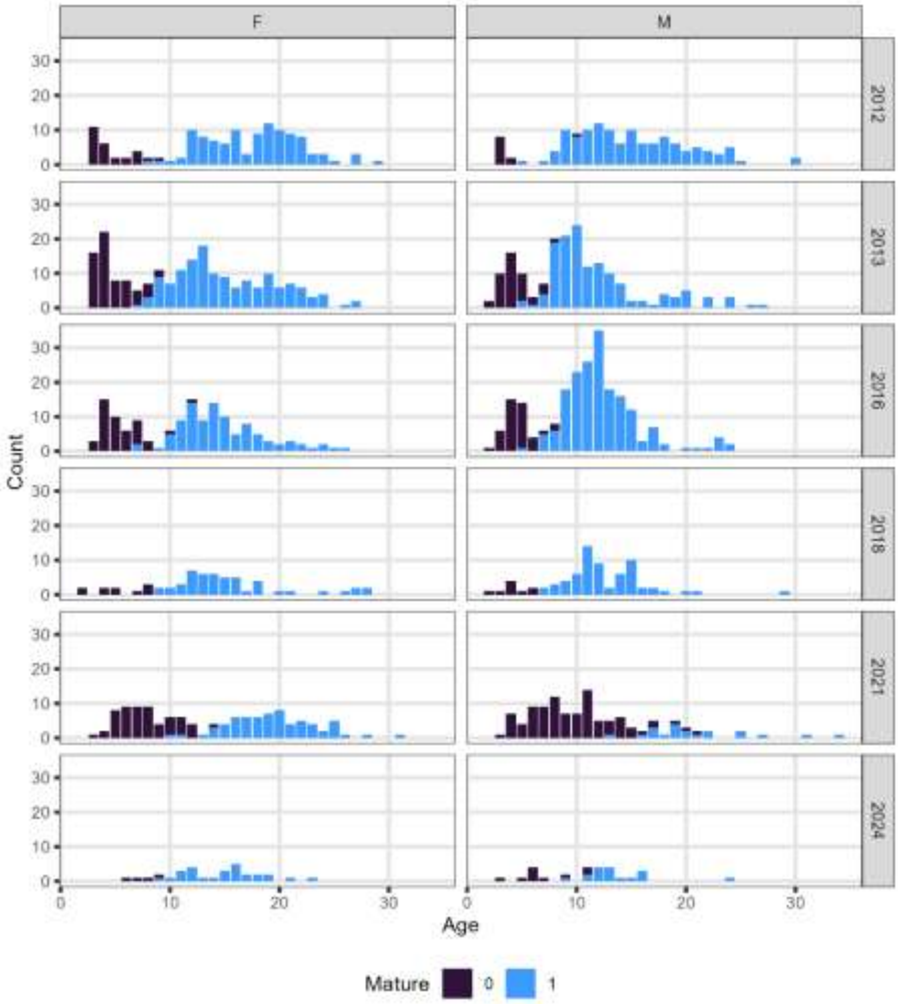


Figure C.13: Ling maturity at age raw data from the West Coast South Island trawl surveys. Immature is defined as stage 1, and mature as stages above 2. Stage 2 is not considered, as per the methodology of Horn (2005).

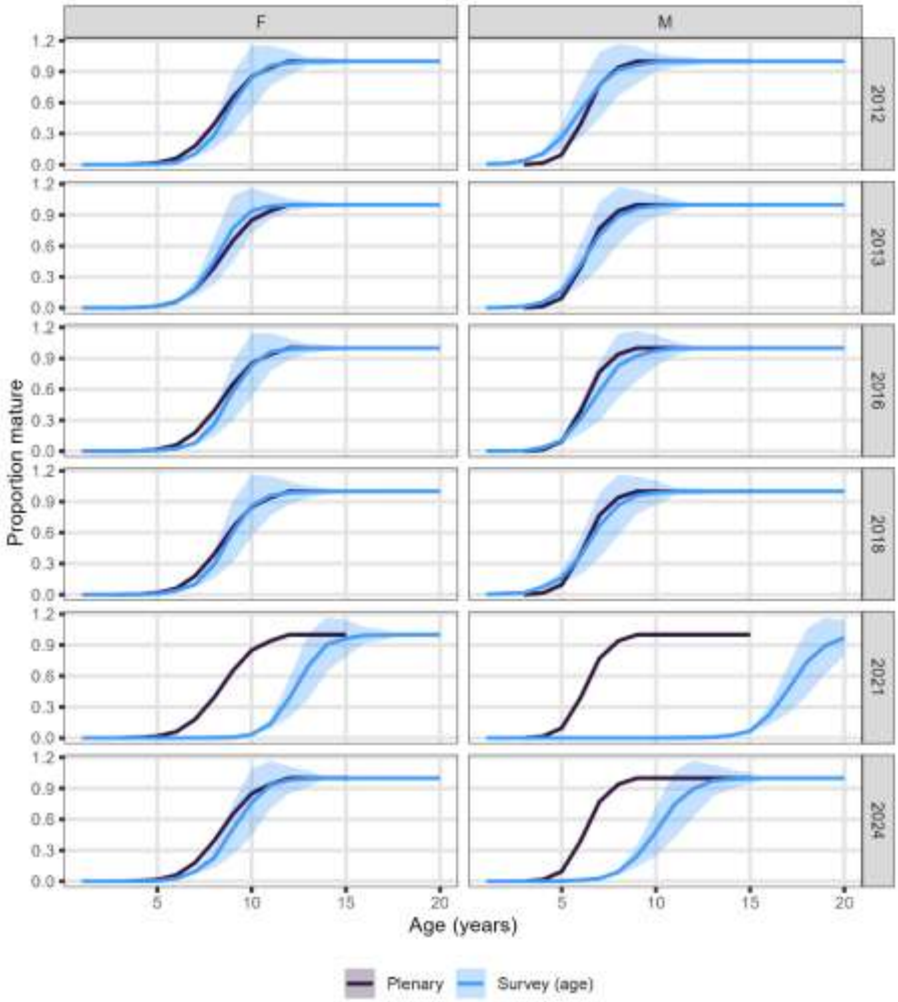


Figure C.14: Ling LIN7WC Bayesian annual estimate of maturity at age based on the data from the West Coast South Island trawl surveys. Immature is defined as stage 1, and mature as stages above 2. Stage 2 is not considered, as per the methodology of Horn (2005) for survey data. The Plenary value used in the previous stock assessment is also plotted (Mormede et al. 2024e; Fisheries New Zealand 2026).

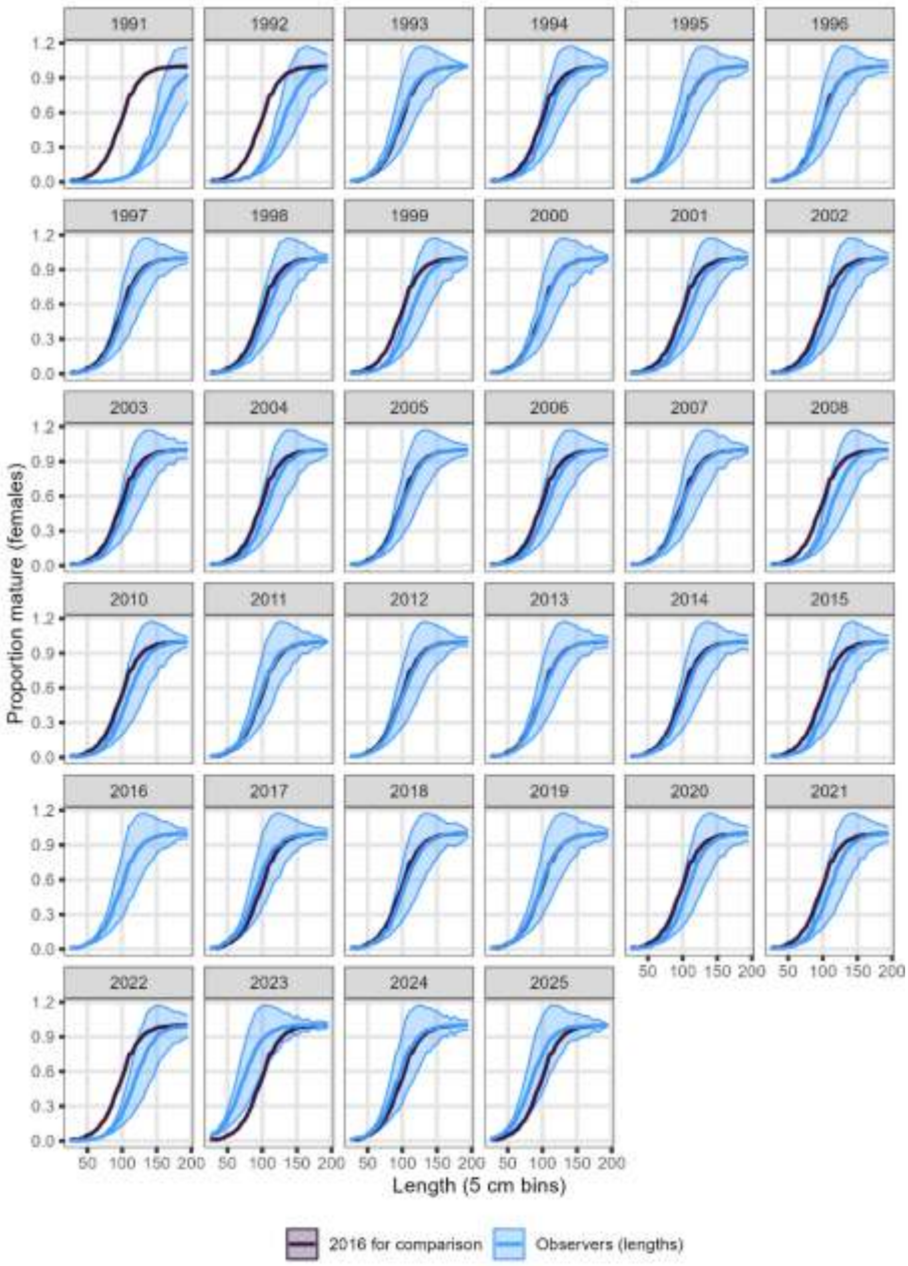


Figure C.15: Ling LIN7WC Bayesian annual estimate of maturity at length based on observer data. Immature is defined as stage 1, and mature as stages 2 and above, as per the methodology of Horn (2005) for observer data. The 2016 estimate is repeated in all the facets to help comparison between years.

15. APPENDIX D – CPUE ANALYSES (LIN 7WC)

Table D.1: Explanatory variables provided to the bottom trawl commercial CPUE model.

Variable	Type	Description
Year	Categorical	Model year (January to December)
Month	Categorical	Month of the year
Target	Categorical	Target species: hoki, hake or ling
Vessel	Random effect	Unique vessel identifier
Day of year	5th degree spline	Julian date, starting on 1 January
Effort height	6th degree spline	Height of the net (m)
Effort width	6th degree spline	Wingspread (m)
Fishing depth	6th degree spline	Depth of the fishing gear (m)
Bottom depth	6th degree spline	Depth of the bottom (m)
Fishing duration	6th degree spline	Fishing duration (decimal hours)
Moon phase	5th degree cyclic cubic spline	Moon phase (from 0 to 1)
Start latitude and Start longitude	10th degree two-dimensional spline	Latitude of the start position Longitude of the start position (0–360 degrees)
Method	Categorical	Whether the trawl was a bottom trawl (BT), midwater trawl (MW) or midwater trawl within 5 m of the bottom (MB)

Table D.2: Data selection for the bottom trawl commercial CPUE model.

Data source	TCEPR, ERS
Year range	1990–2025
Target species	hoki, hake, and ling
Rolling-up method	none
Statistical Areas	Statistical Area 034–036, 703 (50 or more tows per area)
Catch per tow	< 10 t
Gear type	BT, MW, MB (MB=MW within 5m of bottom depth)
Time of year	June to September
Vessel experience	Over 8 years in the fishery
Year definition	Calendar year
Bottom depth	150–900 m
Trawl duration	0.2–15 hours
Catches	Any record where ling is not recorded in the top 5 or top 5 QMS for ERS forms is given a ling catch of 0

Table D.3: Explanatory variables provided to the bottom longline rolled-up CPUE model.

Variable	Type	Description
Year	Categorical	Model year (January to December)
Month	Categorical	Month of the year
Statistical area	Categorical	Statistical area
Vessel	Random effect	Unique vessel identifier
Total hooks	6th degree spline	Number of hooks set per day in a statistical area

Table D.4: Data selection for the bottom longline rolled-up CPUE model.

Data source	CELR, LTCER, LCER, ERS – lining
Year range	1990–2025
Target species	Ling only
Rolling-up method	By vessel, day, and statistical area
Statistical Areas	50 rolled-up records minimum (Statistical Area 032–036 and 703)
Catch per record	< 15 t
Gear type	Bottom longline only
Number of hooks per line	Between 50 and 15 000
Vessel experience	Over 8 years in the fishery
Ling catch reporting position	Any record where ling is not recorded in the top 5 or top 5 QMS for ERS forms is given a ling catch of 0 (<0.01% of catch)
Year definition	Model year: January to December

Table D.5: Variables in order of model definition for the lognormal model for the commercial trawl CPUE of ling off the west coast of the South Island (LIN 7WC). All variables were retained in the model.

Term	Log likelihood	AIC	r^2	Deviance explained
Intercept	-92 955	185 915	0.00	0.00
year	-92 672	185 403	0.01	0.01
month	-92 280	184 626	0.02	0.02
method	-90 233	180 536	0.08	0.08
target	-90 047	180 167	0.09	0.09
s(EffortHeight, bs = "ts", k = 6)	-89 639	179 360	0.10	0.10
s(EffortWidth, bs = "ts", k = 6)	-88 796	177 684	0.12	0.12
s(FishingDepth, bs = "ts", k = 6)	-88 167	176 436	0.14	0.14
s(BottomDepth, bs = "ts", k = 6)	-88 133	176 376	0.14	0.14
s(FishingDuration, bs = "ts", k = 6)	-87 388	174 897	0.16	0.16
te(StartLongitude, StartLatitude, k = c(10, 10))	-84 728	169 750	0.23	0.23
s(moon.phase, k = 5, bs = "cc")	-84 716	169 730	0.23	0.23
s(vessel.id, bs = "re")	-83 232	166 854	0.26	0.26
s(day, k = 5, bs = "cc")	-83 212	166 820	0.26	0.26

Table D.6: Variables in order of model definition for the binomial model for the commercial trawl CPUE of the ling stock off the west coast of the South Island (LIN 7WC). All variables were retained in the model.

Term	Log likelihood	AIC	r^2	Deviance explained
Intercept	-70 240	140 482	0.00	0.00
year	-65 133	130 323	0.09	0.07
month	-63 887	127 838	0.12	0.09
method	-60 929	121 927	0.17	0.13
target	-59 059	118 187	0.20	0.16
s(EffortHeight, bs = "ts", k = 6)	-59 009	118 097	0.20	0.16
s(EffortWidth, bs = "ts", k = 6)	-58 715	117 518	0.21	0.16
s(FishingDepth, bs = "ts", k = 6)	-56 196	112 491	0.25	0.20
s(BottomDepth, bs = "ts", k = 6)	-56 100	112 308	0.25	0.20
s(FishingDuration, bs = "ts", k = 6)	-56 066	112 248	0.25	0.20
te(StartLongitude, StartLatitude, k = c(10, 10))	-52 145	104 538	0.32	0.26
s(moon.phase, k = 5, bs = "cc")	-52 139	104 530	0.32	0.26
s(vessel.id, bs = "re")	-49 944	100 231	0.35	0.29
s(day, k = 5, bs = "cc")	-49 900	100 148	0.35	0.29

Table D.7: Variables in order of model definition for the rolled-up longline CPUE for ling off the west coast of the South Island (LIN 7WC). All variables were retained in the model.

Term	Log likelihood	AIC	r^2	Deviance explained
Intercept	-20721	41447	0.00	0.00
year	-20070	40212	0.08	0.08
month	-19603	39300	0.13	0.13
Statistical Area	-19312	38729	0.16	0.17
s(hooks, bs = "ts", k = 6)	-17026	34166	0.38	0.38
s(vessel.id, bs = "re")	-16472	33091	0.42	0.42

Table D.8: CPUE standardised indices for the ling stock off the west coast of the South Island (LIN 7WC) rolled-up bottom longline fishery and commercial trawl fishery and CVs, and CPUE adjusted for 1% annual learning rate as used in the stock assessment. Year is calendar year.

	Bottom longline			Bottom trawl		
Year	CPUE	Adjusted CPUE	CV	CPUE	Adjusted CPUE	CV
1990	855	1 060	0.07			
1991	1 030	1 264	0.06			
1992	1 169	1 421	0.05			
1993	899	1 083	0.05			
1994	867	1 033	0.05			
1995	929	1 096	0.05			
1996	579	677	0.05			
1997	696	805	0.05	1 544	1 783	0.14
1998	782	896	0.04	1 244	1 422	0.14
1999	832	943	0.05	1 536	1 739	0.14
2000	851	955	0.04	1 218	1 365	0.14
2001	1 024	1 138	0.04	1 189	1 319	0.14
2002	948	1 043	0.05	1 039	1 141	0.14
2003	1 057	1 152	0.04	830	903	0.14
2004	1 095	1 182	0.05	935	1 007	0.14
2005	765	817	0.04	882	940	0.14
2006	735	777	0.04	938	991	0.14
2007	1 068	1 118	0.04	962	1 005	0.14
2008	1 010	1 047	0.05	904	936	0.14
2009	1 005	1 032	0.04	1 208	1 238	0.14
2010	1 216	1 236	0.04	992	1 006	0.14
2011	1 071	1 078	0.04	1 082	1 087	0.14
2012	1 113	1 109	0.04	961	956	0.14
2013	1 187	1 171	0.04	1 144	1 127	0.14
2014	1 216	1 188	0.04	1 058	1 031	0.14
2015	1 043	1 009	0.04	1 118	1 079	0.14
2016	1 044	1 000	0.04	1 129	1 079	0.14
2017	1 143	1 083	0.04	1 143	1 081	0.14
2018	1 092	1 025	0.04	947	887	0.14
2019	1 149	1 068	0.04	945	877	0.14
2020	1 094	1 006	0.04	975	895	0.14
2021	915	833	0.04	868	789	0.14
2022	777	701	0.04	808	727	0.14
2023	767	685	0.05	943	841	0.14
2024	617	545	0.05	784	692	0.14
2025	493	432	0.06	637	557	0.14

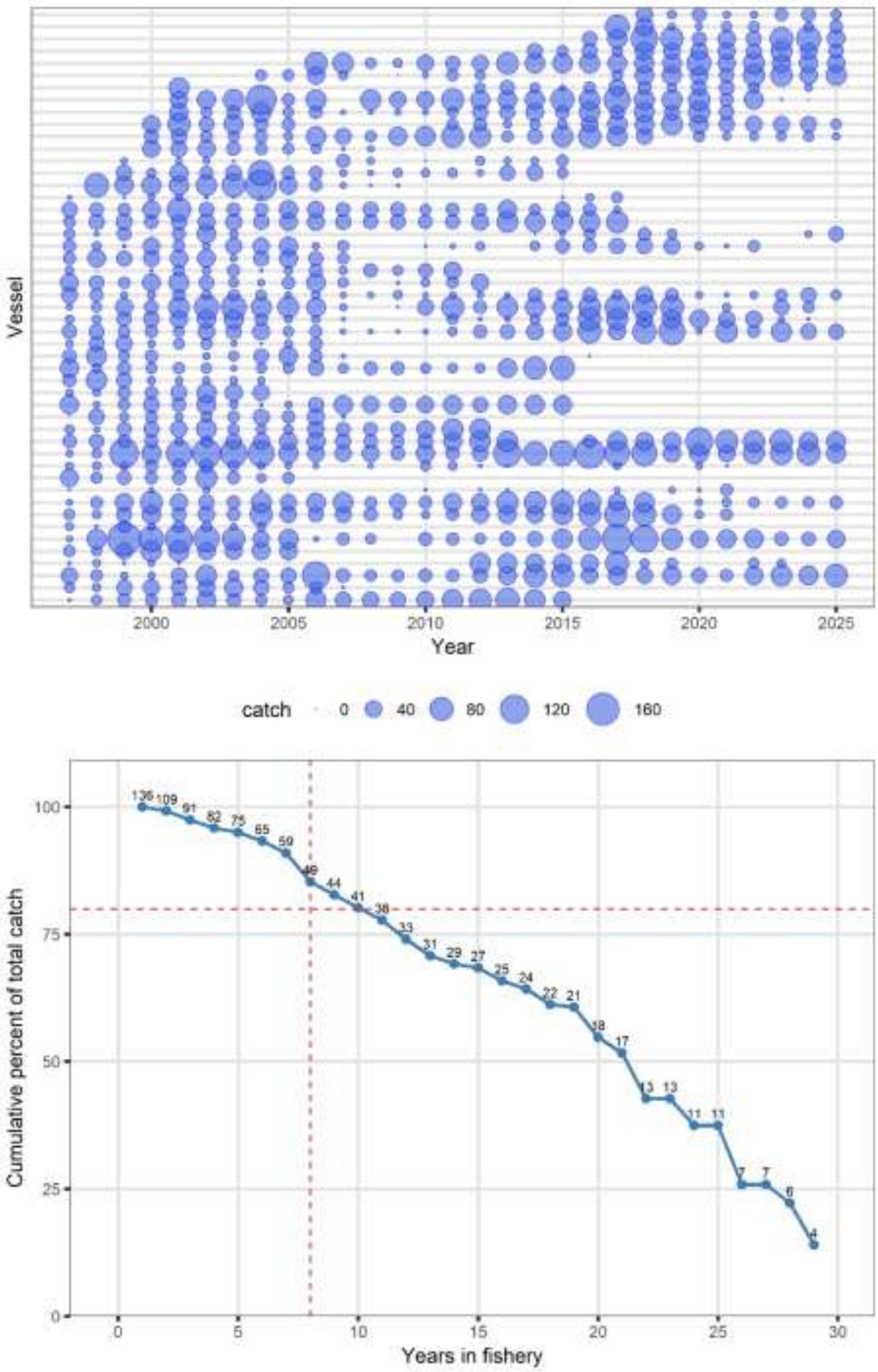


Figure D.1: Core vessel selection for the bottom trawl commercial CPUE model for ling off the west coast of the South Island (LIN 7WC): annual catch per vessel over time (top) and proportion of total catch for vessels that have been in the fishery for a minimum of x years (on the x axis) with the number of vessels included reported (bottom).

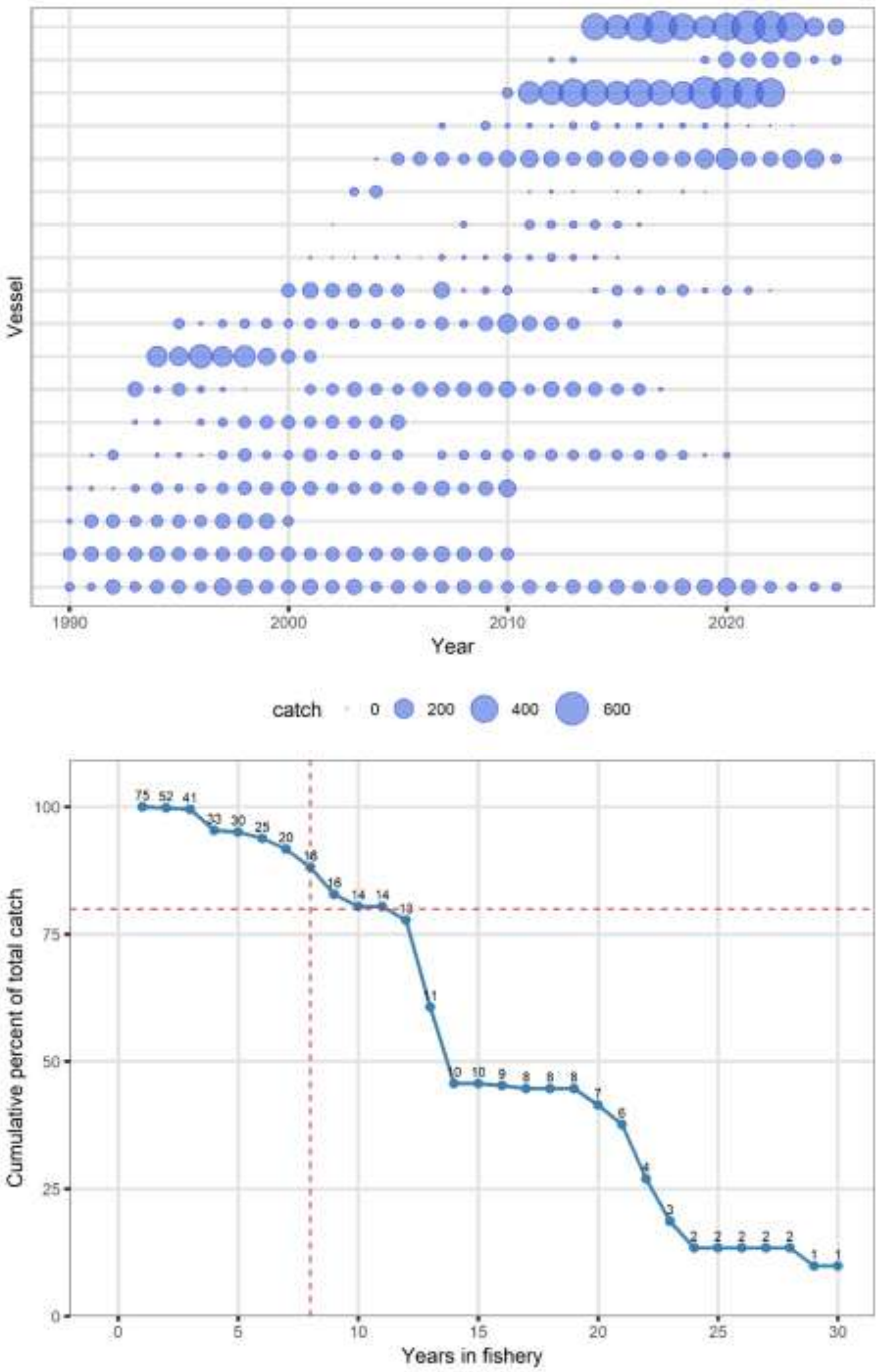


Figure D.2: Core vessel selection for the bottom longline CPUE model for ling off the west coast of the South Island (LIN 7WC): annual catch by vessel over time (top) and proportion of total catch for vessels that have been in the fishery for a minimum of x years (on the x axis) with the number of vessels included reported (bottom).

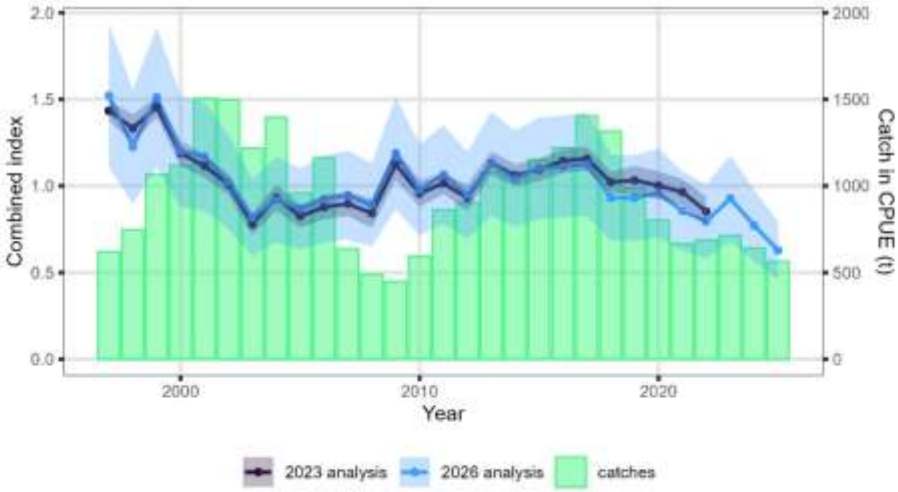


Figure D.3: Year index for the combined model for the bottom trawl CPUE of ling off the west coast of the South Island (LIN 7WC). Also plotted are the previous indices from the 2023 analysis (Mormede et al. 2023a) and the ling catches included in the CPUE index. Year was model year which was defined as calendar year.

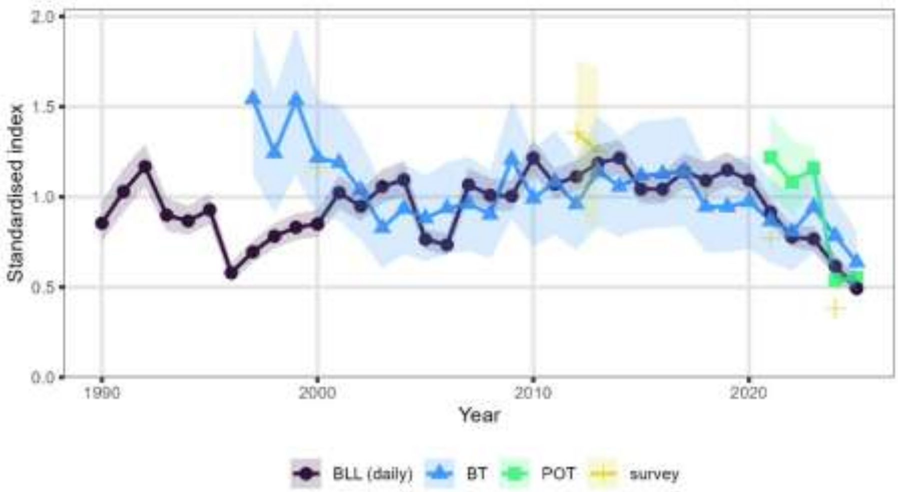


Figure D.4: Year index for the lognormal model for the rolled-up bottom longline CPUE, trawl CPUE and pot CPUE for ling off the west coast of the South Island (LIN 7WC) and survey results. Year was model year which was defined as the calendar year.

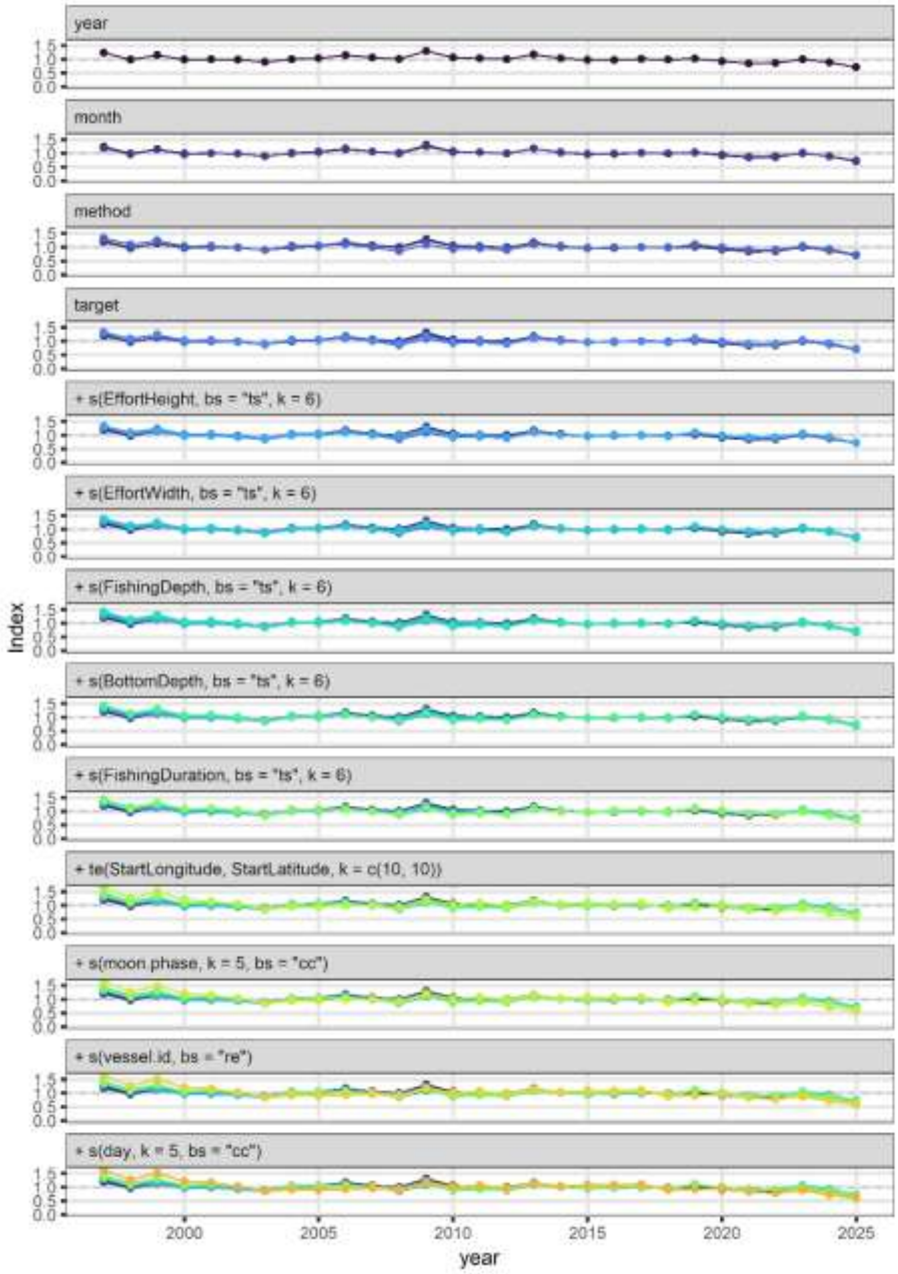


Figure D.5: Influence plots for the lognormal model for the bottom trawl, assuming all other parameters were constant at their median or modal value. Year is model year which was defined as calendar year.

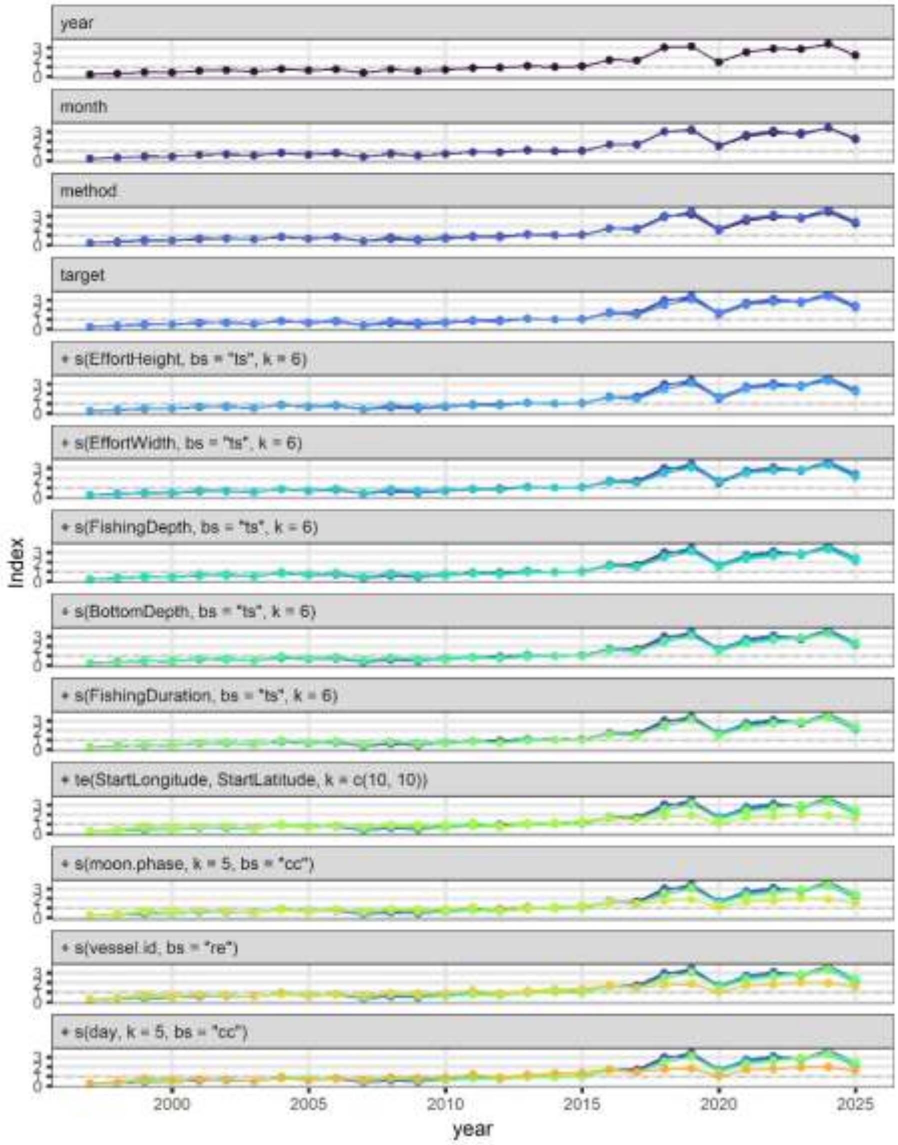


Figure D.6: Influence plots for the binomial model for the bottom trawl CPUE, assuming all other parameters were constant at their median or modal value. Year is model year which was defined as calendar year.

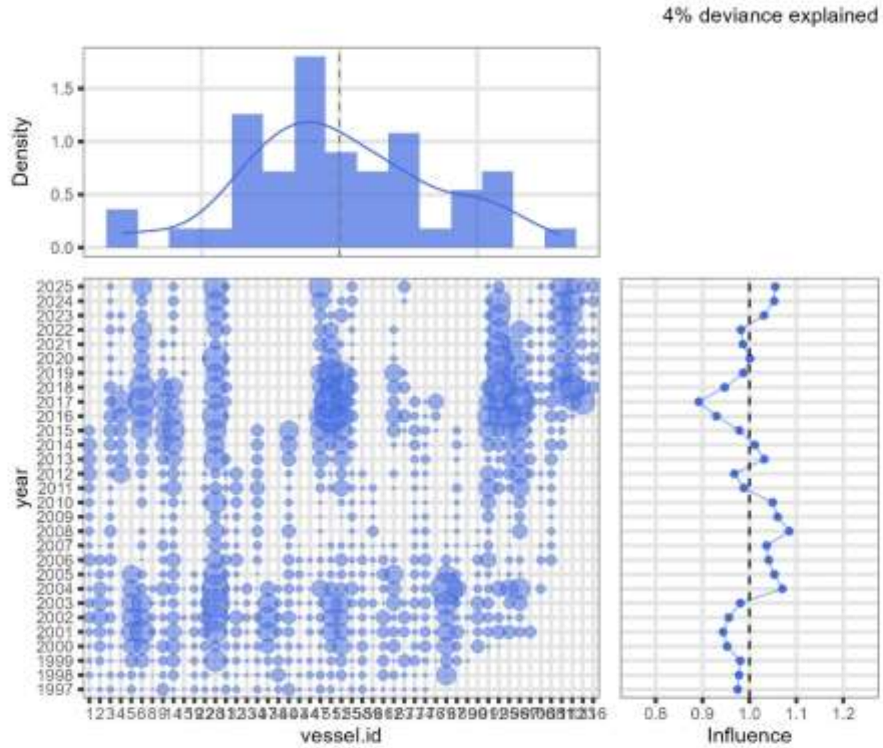


Figure D.7: Influence plots for the lognormal model for the bottom trawl CPUE for vessel identifier in relation to year, assuming all other parameters were constant at their median or modal value. Year is model year which was defined as calendar year.

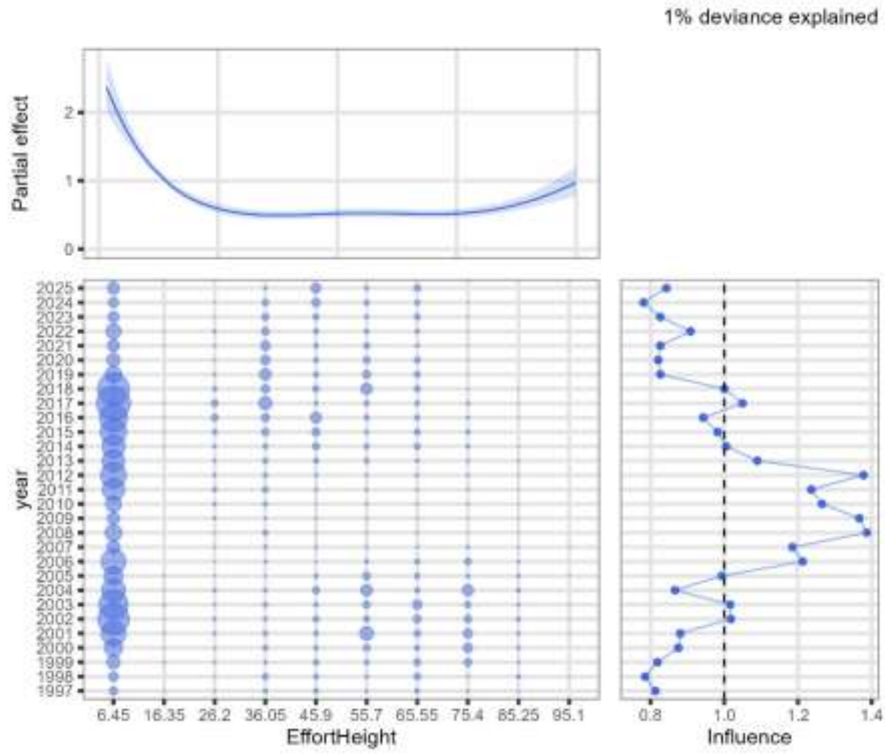


Figure D.8: Influence plots for the lognormal model for the bottom trawl CPUE for effort height (m) in relation to year, assuming all other parameters were constant at their median or modal value. Year is model year which was defined as calendar year.

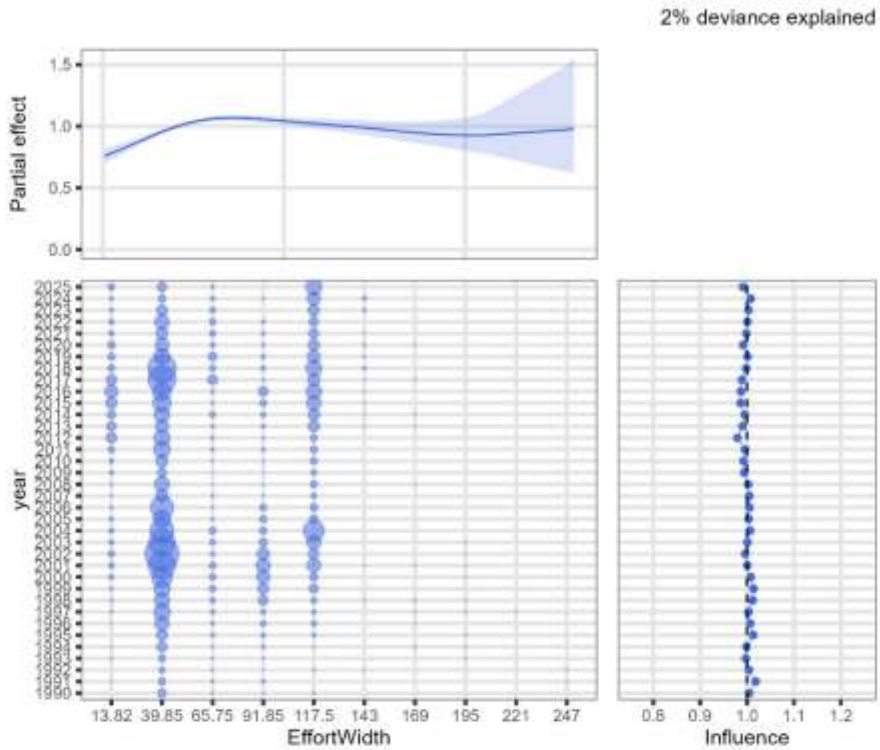


Figure D.9: Influence plots for the lognormal model for the bottom trawl CPUE for effort width (m) in relation to year, assuming all other parameters were constant at their median or modal value. Year is model year which was defined as calendar year.

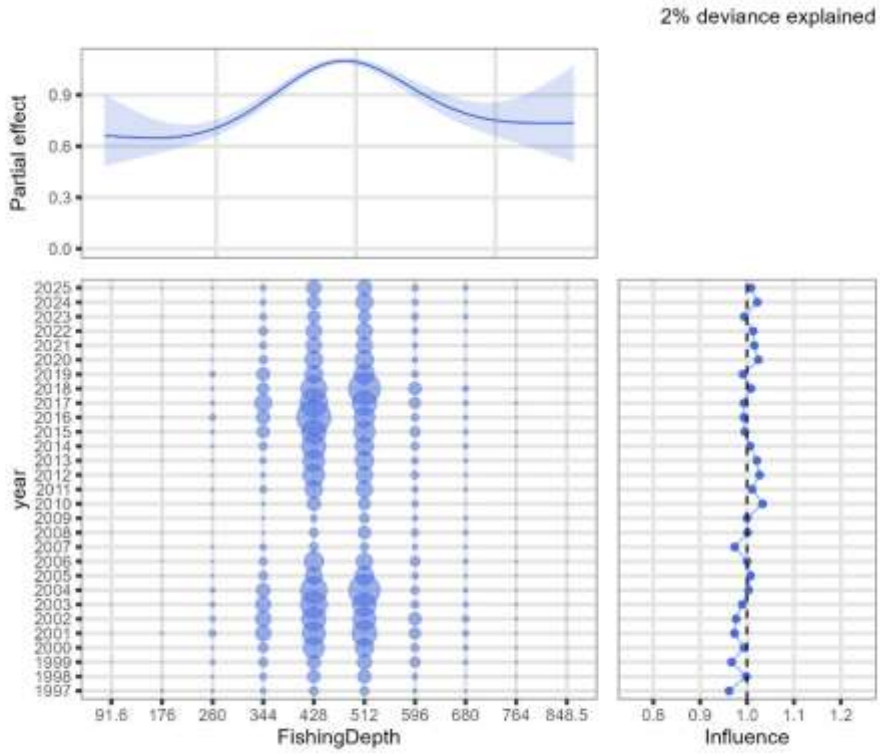


Figure D.10: Influence plots for the lognormal model for the bottom trawl CPUE for fishing depth (m) in relation to year, assuming all other parameters were constant at their median or modal value. Year is model year which was defined as calendar year.

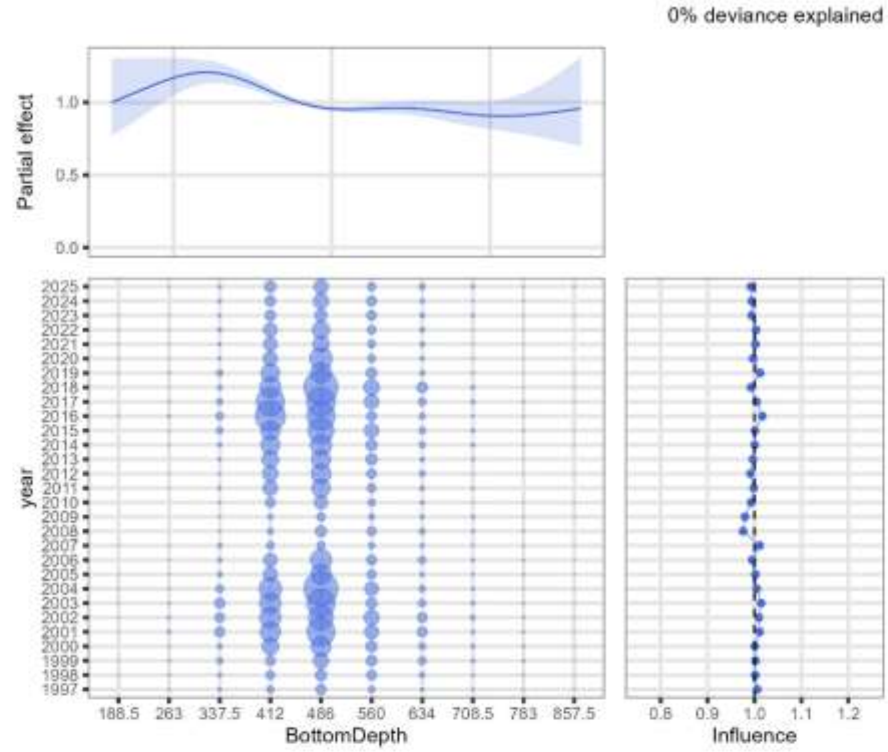


Figure D.11: Influence plots for the lognormal model for the bottom trawl CPUE for bottom depth (m) in relation to year, assuming all other parameters were constant at their median or modal value. Year is model year which was defined as calendar year.

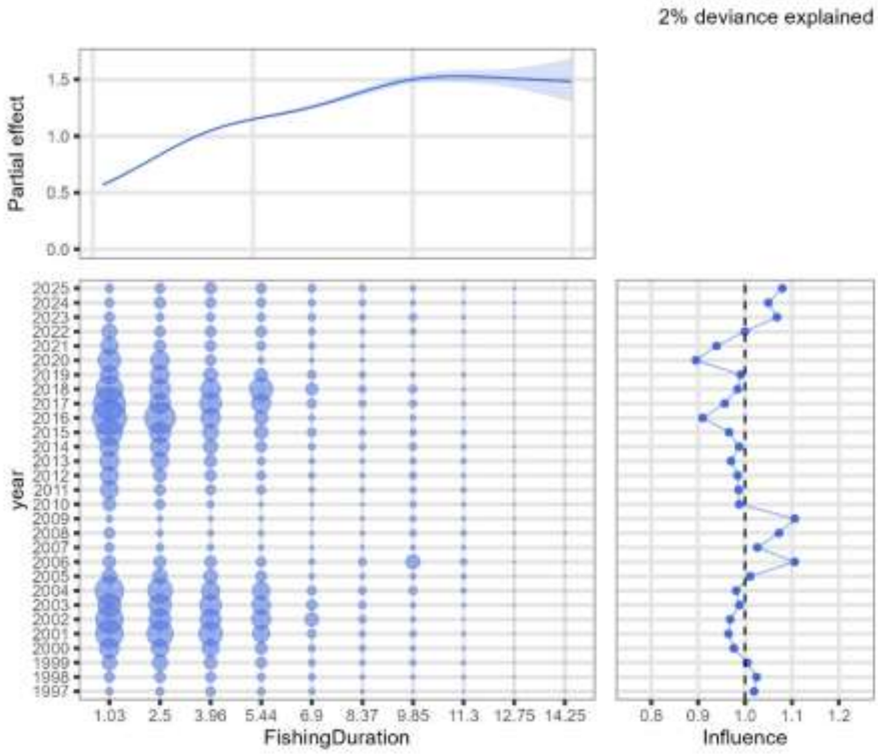


Figure D.12: Influence plots for the lognormal model for the bottom trawl CPUE for fishing duration (hours) in relation to year, assuming all other parameters were constant at their median or modal value. Year is model year which was defined as calendar year.

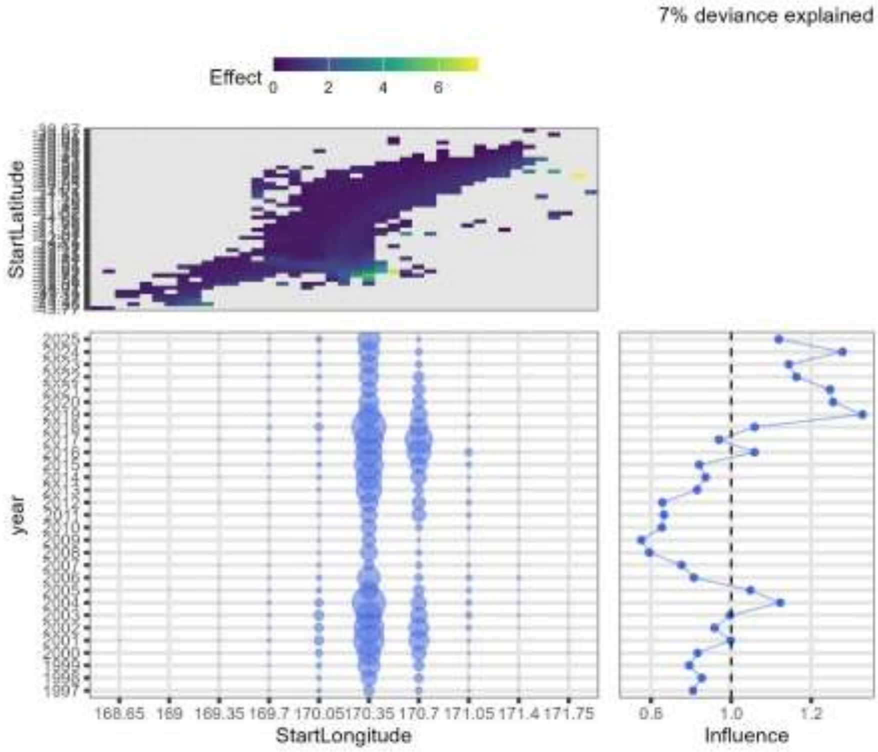


Figure D.13: Influence plots for the lognormal model for the bottom trawl CPUE for the latitude and longitude of the start of the tow in relation to year, assuming all other parameters were constant at their median or modal value. Year is model year which was defined as calendar year, and month 1 was January.

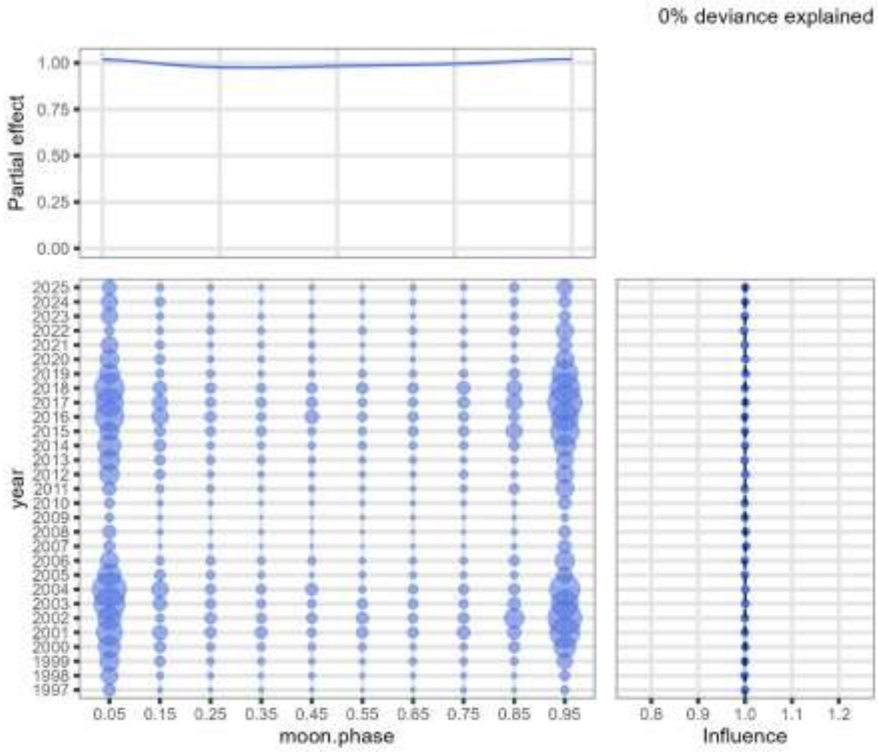


Figure D.14: Influence plots for the lognormal model for the bottom trawl CPUE for the moon phase in relation to year, assuming all other parameters were constant at their median or modal value. Year is model year which was defined as calendar year, and month 1 was January.

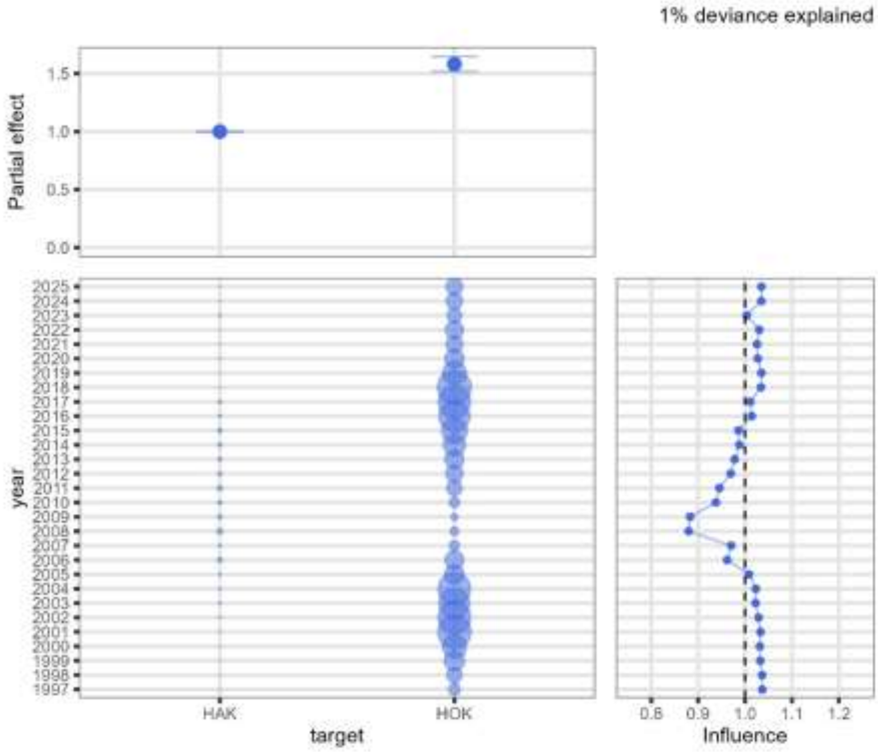


Figure D.15: Influence plots for the lognormal model for the bottom trawl CPUE for the target in relation to year, assuming all other parameters were constant at their median or modal value. Year is model year which was defined as calendar year, and month 1 was January.

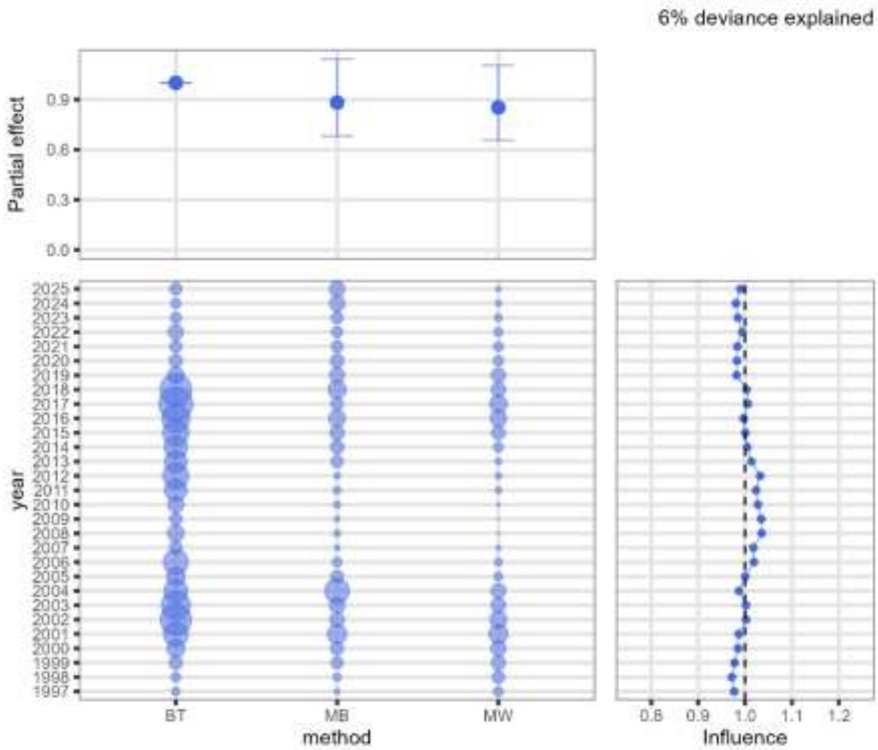


Figure D.16: Influence plots for the lognormal model for the bottom trawl CPUE for the method in relation to year, assuming all other parameters were constant at their median or modal value. Year is model year which was defined as calendar year, and month 1 was January.

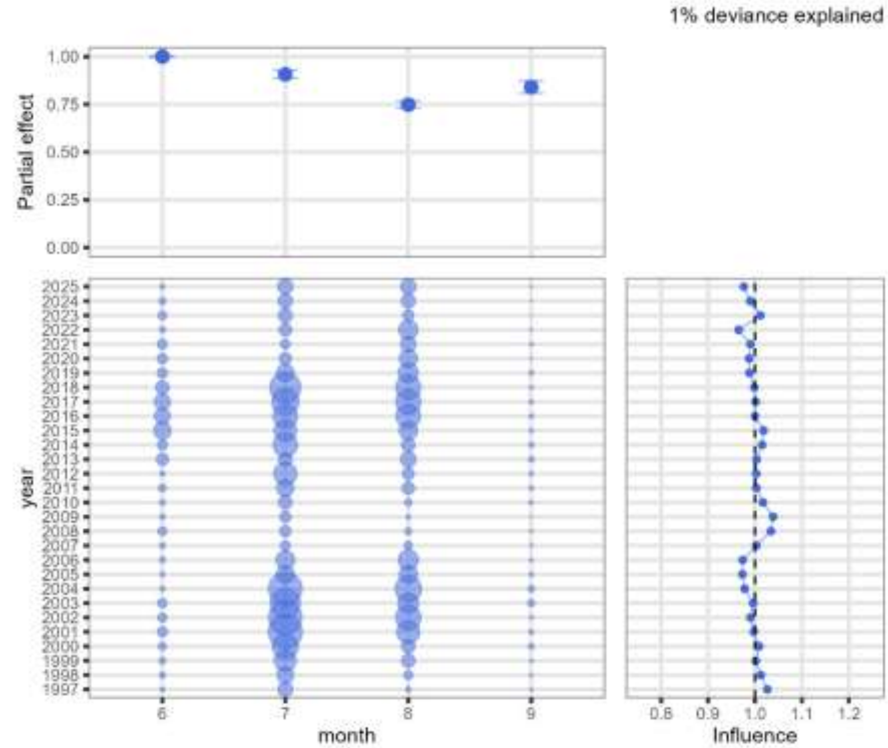


Figure D.17: Influence plots for the lognormal model for the bottom trawl CPUE for the month in relation to year, assuming all other parameters were constant at their median or modal value. Year is model year which was defined as calendar year, and month 1 was January.

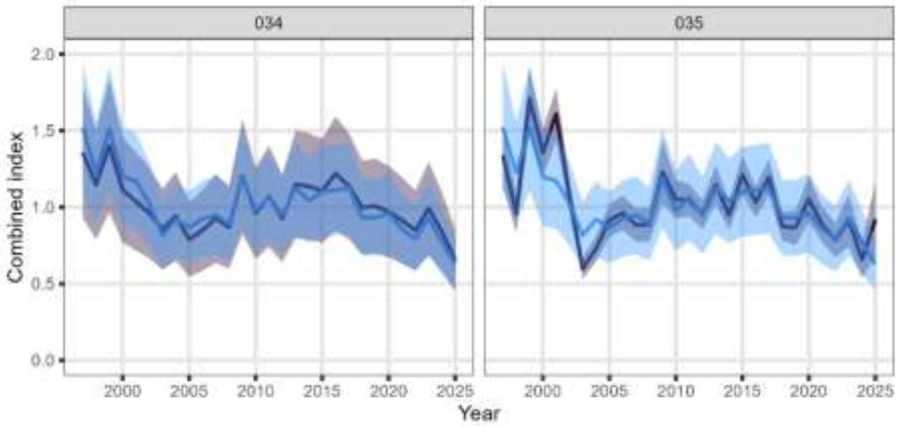


Figure D.18: Comparison between the single model for all statistical areas combined and the models for each statistical area and credible intervals for the bottom trawl CPUE. Year was model year which was defined as calendar year.

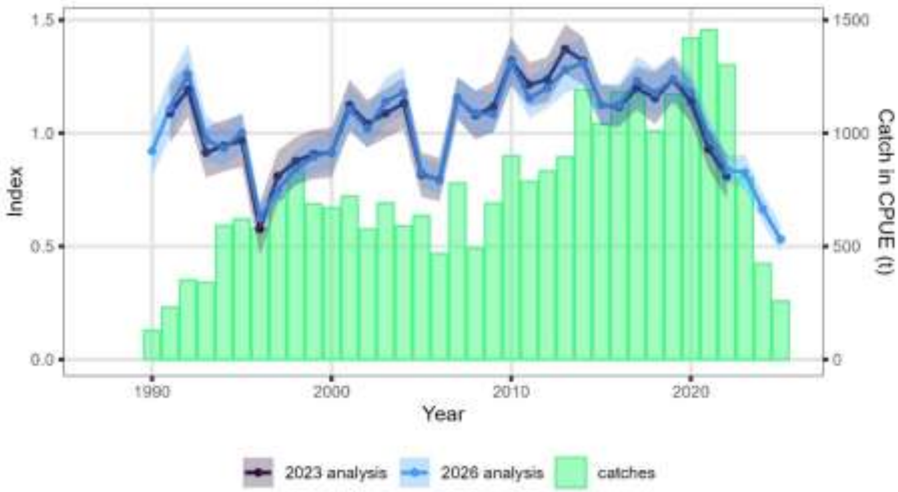


Figure D.19: Year index for the lognormal model for the rolled-up bottom longline CPUE for ling off the west coast of the South Island (LIN 7WC). Also plotted is the bottom longline CPUE from the previous analysis indices (Mormede et al. 2023a) and the total ling catches used in the model. Year was model year which was defined as the calendar year.

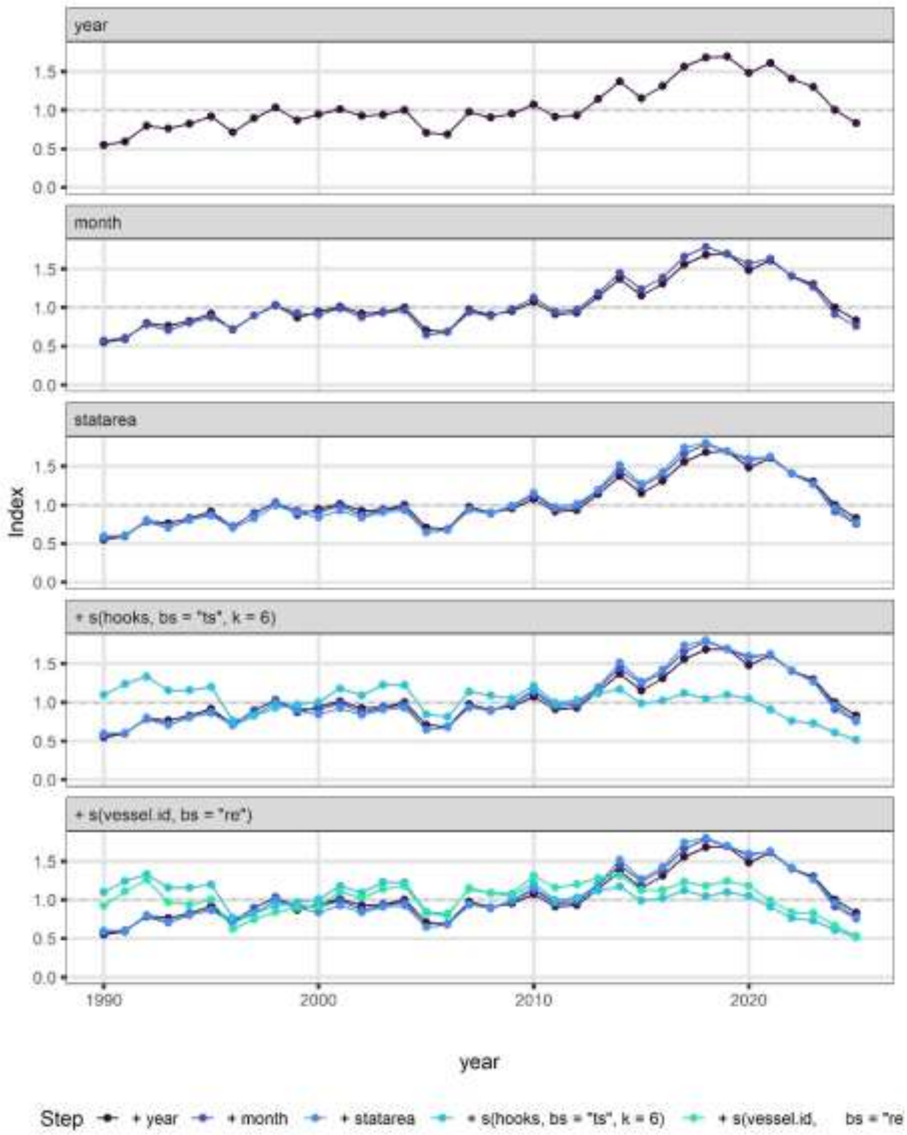


Figure D.20: Influence plots for the lognormal model for the rolled-up bottom longline CPUE, assuming all other parameters were constant at their median or modal value. Year was model year which was defined as the calendar year.

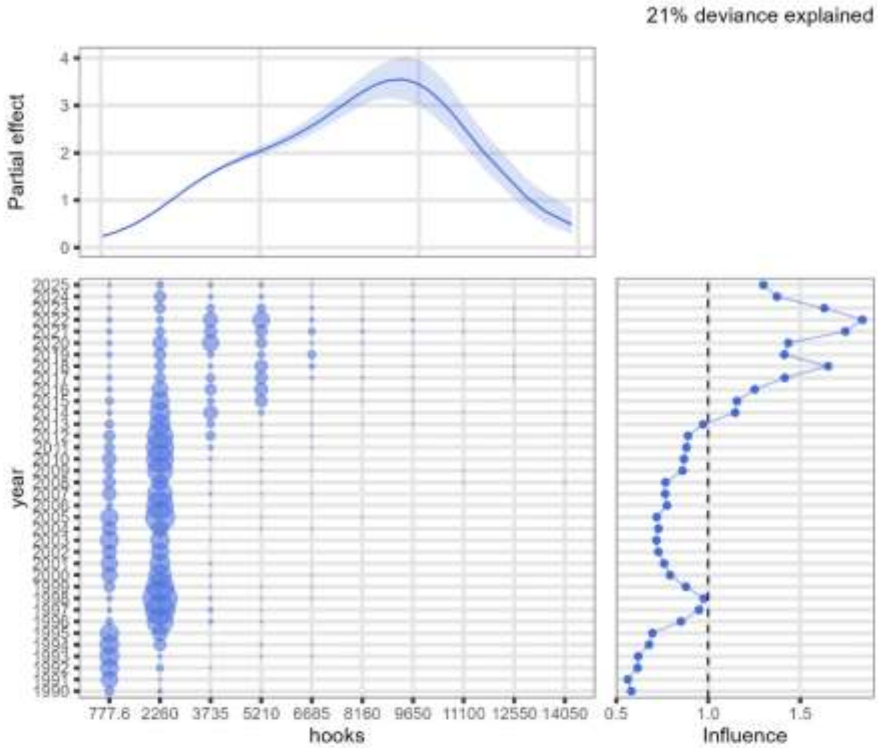


Figure D.21: Influence plots for the lognormal model for the rolled-up bottom longline CPUE for the number of hooks (per set) in relation to year, assuming all other parameters were constant at their median or modal value. Year was model year which was defined as the calendar year.

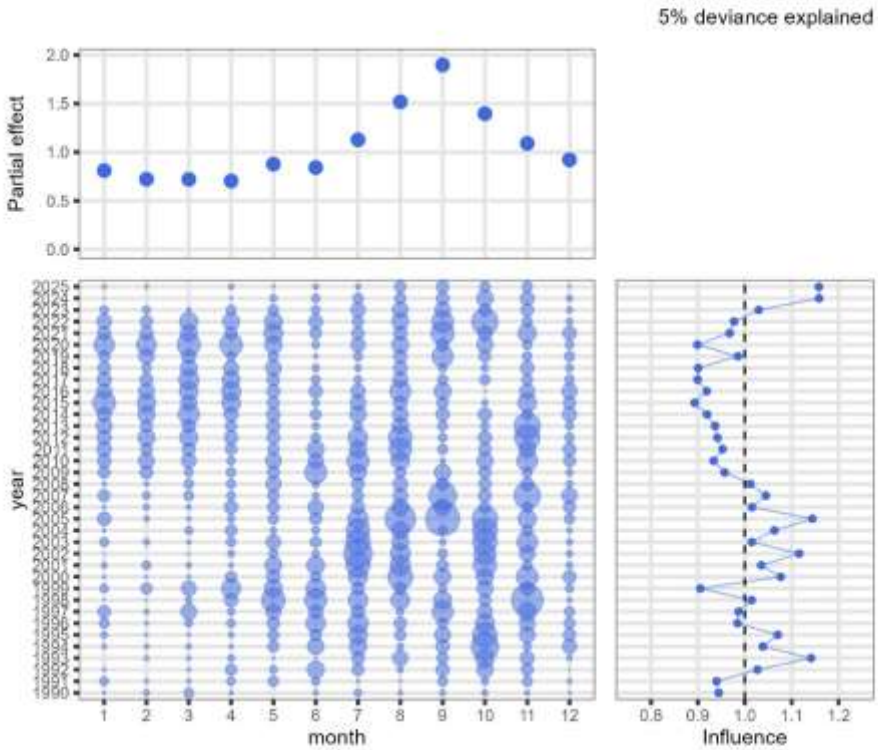


Figure D.22: Influence plots for the lognormal model for the rolled-up bottom longline CPUE for month in relation to year, assuming all other parameters were constant at their median or modal value. Year was model year which was defined as the calendar year, and month 1 is January.

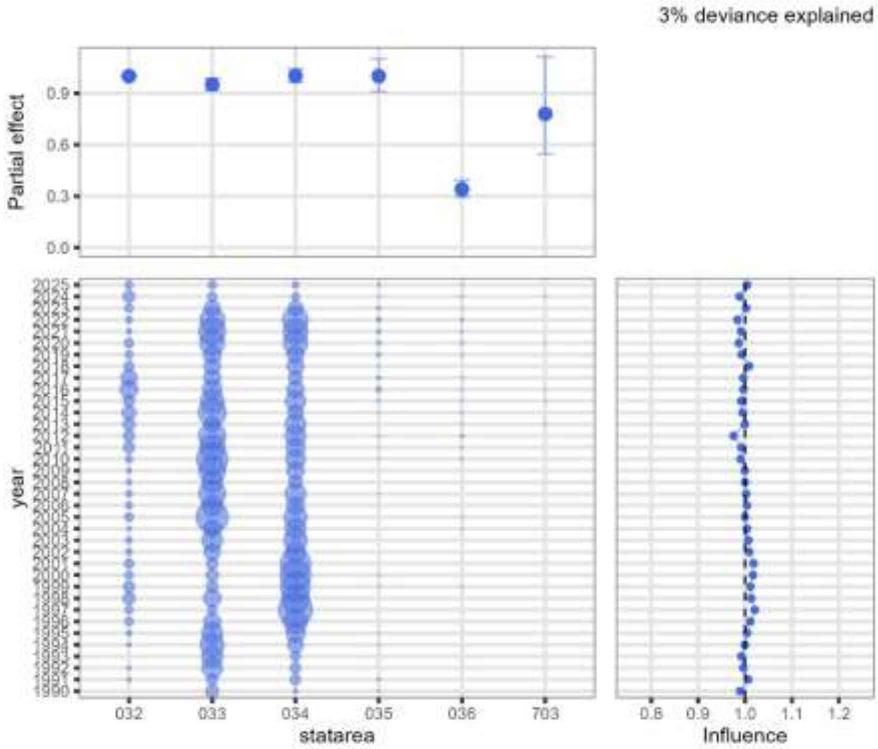


Figure D.23: Influence plots for the lognormal model for the rolled-up bottom longline CPUE for statistical area in relation to year, assuming all other parameters were constant at their median or modal value. Year was model year which was defined as the calendar year, and month 1 is January.

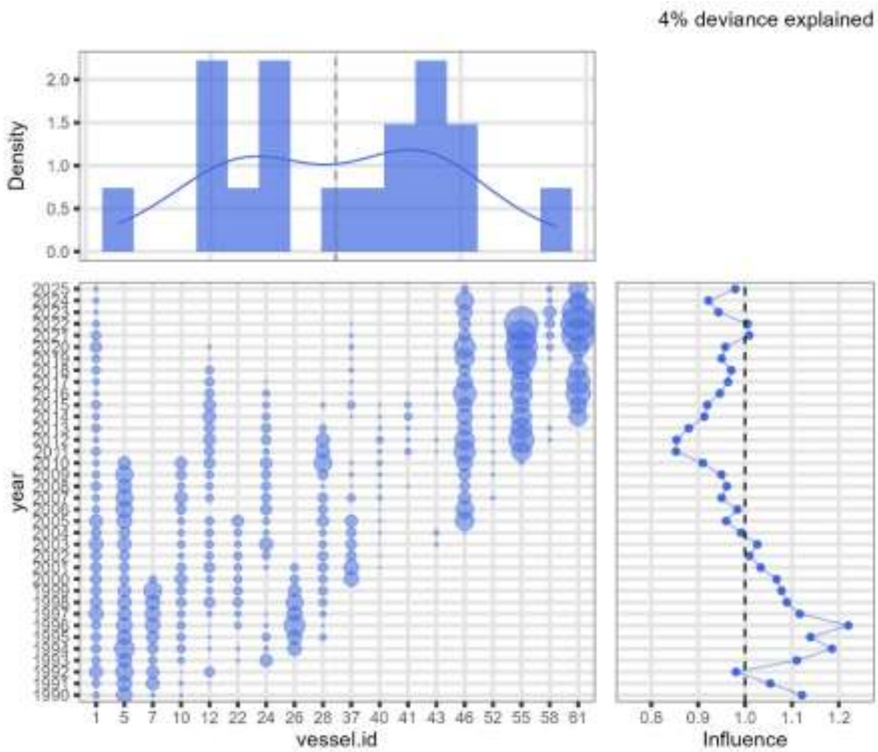


Figure D.24: Influence plots for the lognormal model for the rolled-up bottom longline CPUE for vessel identifier in relation to year, assuming all other parameters were constant at their median or modal value. Year was model year which was defined as the calendar year.

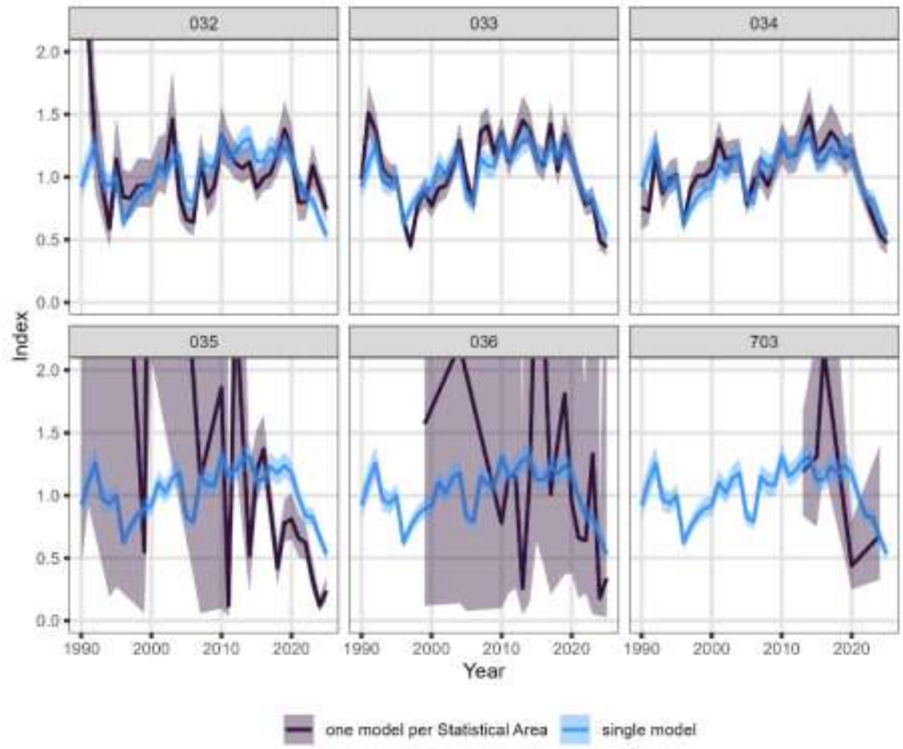


Figure D.25: Comparison between the single model for all statistical areas combined and the models for each statistical area and credible intervals for the bottom longline daily CPUE. Year was model year which was defined as calendar year.

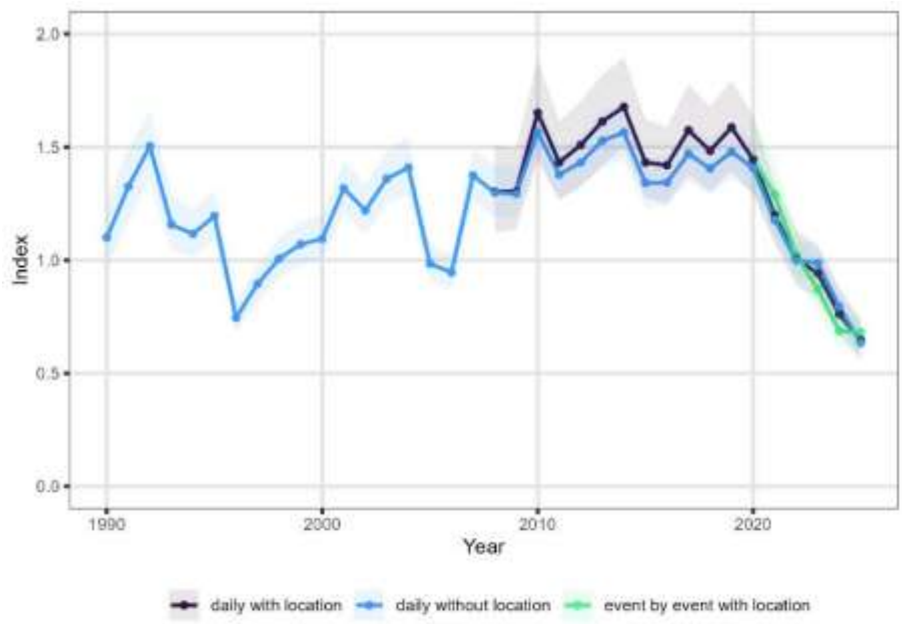


Figure D.26: Comparison between the different sensitivity runs for the bottom longline daily CPUE, with increasing precision of reporting. Year was model year which was defined as calendar year.

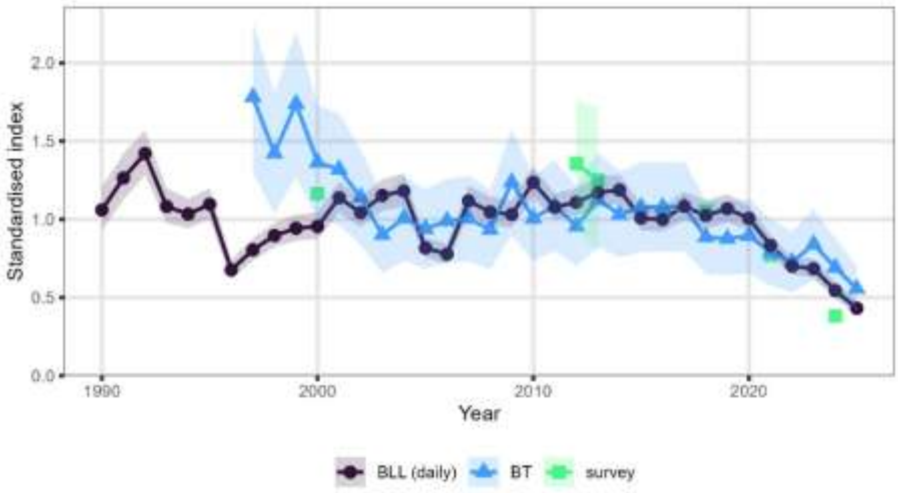


Figure D.27: Year index for the lognormal model for the rolled-up bottom longline CPUE and trawl CPUE for ling off the west coast of the South Island (LIN 7WC) including a 1% annual learning rate correction factor and survey results. Year was model year which was defined as the calendar year.

16. APPENDIX E – INPUTS TO THE 2026 STOCK ASSESSMENT

Table E.1: Annual scaled catch in tonnes per fishery used in the 2026 stock assessment of LIN7WC. Year was model year which was defined as the calendar year. Trawl represents all catches other than bottom longline or potting.

Year	Trawl	Longline	Potting
			0
1972	0	0	0
1973	85	20	0
1974	144	40	0
1975	401	800	0
1976	565	2 100	0
1977	715	4 300	0
1978	300	323	0
1979	539	360	0
1980	540	305	0
1981	492	300	0
1982	675	400	0
1983	1 040	710	0
1984	924	595	0
1985	1 156	302	0
1986	1 082	362	0
1987	1 105	370	0
1988	1 428	291	0
1989	1 959	370	0
1990	2 695	259	0
1991	2 046	456	0
1992	1 777	931	0
1993	1 591	739	0
1994	1 442	969	0
1995	1 385	868	0
1996	1 877	861	0
1997	2 068	1 350	0
1998	2 045	1 073	0
1999	2 191	900	0
2000	2 386	935	0
2001	2 382	999	1
2002	2 475	762	0
2003	2 094	926	0
2004	2 092	764	0
2005	1 595	845	0
2006	1 773	781	0
2007	1 323	1 161	0
2008	1 150	1 021	0
2009	1 216	992	0
2010	1 386	1 199	0
2011	1 606	1 143	0
2012	1 697	1 285	0
2013	1 959	1 089	0
2014	1 914	1 444	0
2015	2 092	1 349	2
2016	2 159	1 471	15
2017	2 451	1 470	0
2018	2 440	1 225	15
2019	1 834	1 400	8
2020	1 687	1 752	0
2021	1 406	1 847	210
2022	1 482	1 590	213
2023	1 488	1 184	739
2024	1 244	1 215	765
2025	903	872	581