Department of Primary Industries
Department of Regional NSW

NSW Stock Status Summary – 2023/24

Pink Ling (*Genypterus blacodes*)

Assessment Authors and Year

Smoothey, AF 2023. NSW Stock Status Summary 2023/24 – Pink Ling (*Genypterus blacodes*). NSW, Department of Primary Industries, Fisheries. 18 pp.

Stock Status

Current stock status	On the basis of the evidence contained within this assessment, Pink Ling are currently assessed as **sustainable**.

Stock structure & distribution

Pink Ling (*Genypterus blacodes*) are distributed around the south of Australia from the central NSW coast to southern Western Australia, including Tasmania. Pink Ling is a deep-water species commonly associated with muddy bottoms on the continental shelf and upper slope at depths of 200–900 m. Clear and persistent differences in size and age composition (Morison et al. 2013) and differences in trends in Commonwealth commercial catch rates indicate the existence of different stocks east and west of South Cape, Tasmania (147° East) but no genetic differences have been identified between these areas (Daley et al. 2000; Ward et al. 2001; Butler et al. 2023). The differences in biological characteristics and catch-rate trends have led to Pink Ling being assessed as separate stocks east and west of longitude 147°E since 2013, yet managed under a single TAC, with management arrangements in place to constrain fishing on eastern stocks to the eastern catch limit (Butler et al. 2023). The eastern Pink Ling stock, described for the Commonwealth assessment, is associated with Commonwealth fishing zones 10, 20 and 30 (with catches from Zone 60 assigned to Zone 30; Cordue 2015). The assessment summarised here is that for eastern Pink Ling only, unless otherwise stated in the text. The assessment is detailed in Cordue (2018 and 2022) and summarised in Butler et al. (2023).

Scope of this assessment

The fishery scientific assessment summarised in this report is considered adequate to meet the legislative requirements for supporting a total allowable catch (TAC) determination for the stocks of NSW Pink Ling. This determination is based on the Commonwealth Assessment that is commissioned by the Australian Fisheries Management Authority (AFMA) and published as 'eastern Pink Ling' in the 'Pink Ling (*Genypterus blacodes*)' section of the Fishery Status Reports by the Australian Bureau of Agricultural and Resource Economics and Sciences, (Butler et al. 2023). The Commonwealth assessment references quantitative stock assessments for Pink Ling, including those for eastern Pink Ling in 2018 (Cordue 2018) and a recent update in 2021 (Cordue 2022).

The structure of this stock status summary is consistent with a format to inform a species status determination against criteria for the Status of Australian Fish Stocks reports (SAFS; www.fish.gov.au). It does not attempt to replicate the detail of the Commonwealth assessment but cites key information from that assessment. Assessment of the status of the stock of Pink Ling that is fished by commercial and recreational fishers in New South Wales (NSW) is principally based on the modelling and assessment done for this species by the Commonwealth of Australia. The primary mechanism for controlling the harvest of Pink Ling in the Southern and Eastern Scalefish and Shark Fishery (SESSF) is through the allocation of an Annual Total Allowable Catch (TAC).

Determination of annual TACs for the Commonwealth SESSF is based on the SESSF Harvest Strategy Framework (HSF) (AFMA, 2017) that derives from the Commonwealth Fisheries Harvest Strategy Policy (HSP) (DAFF, 2007).

The Commonwealth assessment of the Pink Ling stock evaluates stock status relative to Limit and Target Reference Points prescribed in the HSF/HSP. The Tier 1 assessment uses a statistical catch-at-length and catch-at-age model. The model provides retrospective and prospective estimates of biomass (the latter for alternative TACs) and generates, through harvest control rules, a Recommended Biological Catch (RBC). The intention of this process is to move the stock biomass toward and maintain it around the Target Reference Point.

This assessment of the status of Pink Ling, in waters under NSW jurisdiction, comprises:

(1) a summary of the most recent Commonwealth stock assessment for Pink Ling (Cordue 2022) and current determinations of status based on criteria specified by the Commonwealth and also those used for the Status of Australian Fish Stocks (SAFS);

(2) the rationale by which the Commonwealth assessment for Pink Ling is considered to be relevant and valid for determining the status of the Pink Ling stock fished within NSW jurisdiction (Appendix 1);

(3) information that may inform the determination of the 2024-25 NSW TAC for Pink Ling in the Ocean Trap and Line – Line East Fishery, Line Easter (Appendix 2). This is done in the absence of: (i) a formal NSW harvest strategy for this species/fishery; and (ii) a formal resource sharing agreement between NSW and the Commonwealth.

Biology

Pink Ling are demersal species that inhabit the continental shelf and slope waters around the south of Australia. They grow to a maximum length of 1.6 m and an age of about 26 years. Males and females have been recorded to mature at about 40–46 cm and 50–58 cm total length (TL), respectively. Spawning occurs during late winter and early spring. Pink Ling are believed to be serial spawners, releasing egg batches in a floating gelatinous mass each spawning event with females producing around 333 000 eggs per spawning event, depending on the body size (AFMA, 2022).

Fishery statistics

Catch information

Commercial

Fishery statistics underpinning the Commonwealth assessment and summarised here from Butler et al. (2023) and references therein. Within the Commonwealth, eastern and western stocks of Pink Ling are assessed separately but managed under a single TAC, with management arrangements in place to constrain fishing on eastern stocks to the eastern catch limit (Butler et al. 2023). Descriptions of NSW fishery statistics are provided in Appendix 2 of this report and the changes in NSW commercial fishery reporting requirements and sources of NSW commercial fishery data are discussed.

The catch information underpinning the Commonwealth assessment is summarised from Butler et al. (2023). Eastern and western catches of Pink Ling increased from the start of the fishery in about 1977, reaching a peak of 2,412 t in 1997 (Figure 1a). From 1997 to 2001, catches declined steadily to about 1,800 t in 2004, despite TACs continuing to increase. From 2004-05 to 2013-14, Pink Ling catches were limited by the TAC (Figure 1b). Since 2013-14, catches have been stable at around 800 to 1,100 t.

In the 2022-23 fishing season, Commonwealth-landed catch was 983.4 t, based on CDRs, with 47% of the catch from the east. Discards and state catches were not available for 2022-23 assessment. However, weighted averages of the previous four calendar years (2018 to 2021) estimated discards and state catches of 37 t and 52.5 t, respectively in the east and 5.1 t and 0.5 t, respectively, in the west (Althaus et al. 2022). For the 2022-23 fishing season, total catch and discards were estimated to be 551.7 t in the east and 526.8 t in the west.

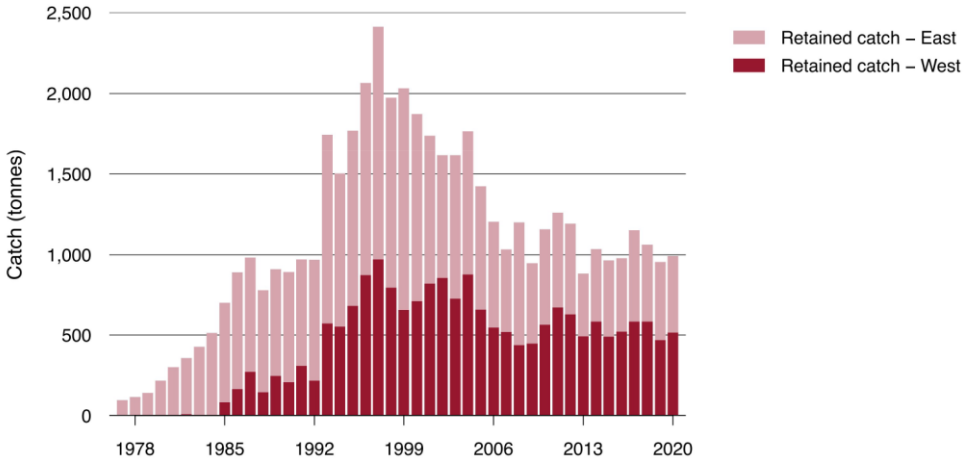


Figure 1a **Pink Ling annual catches (Commonwealth Trawl Sector, Scalefish Hook Sector and states combined) and discards, 1977 to 2020 (Butler et al. 2023).**

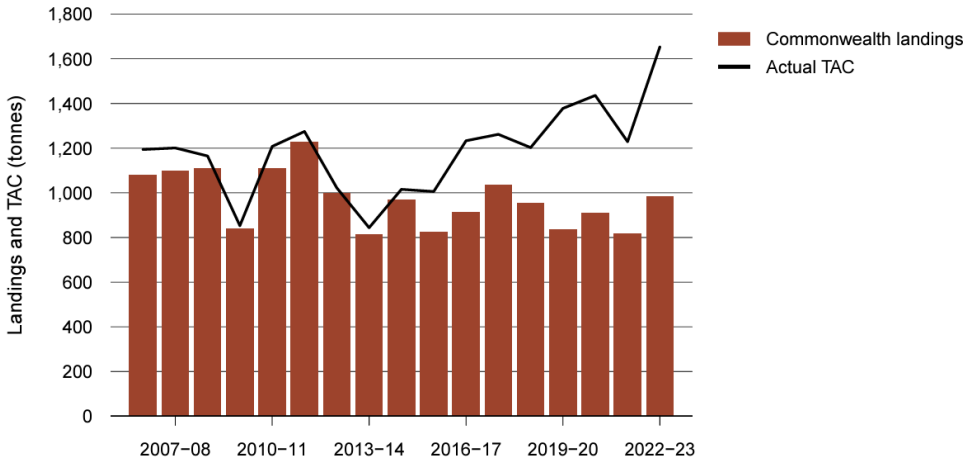


Figure 1b Pink Ling seasonal landings (SESSF) and TACs, 2006-07-2022-23 fishing season (from Butler et al. 2023).

Recreational & Charter boat

The Commonwealth assessment does not, at present, include estimates of Pink Ling catches by the recreational sector. The model is conditioned on commercial catch data alone. Neither does the process by which the Commonwealth TAC is calculated from the RBC account for recreational catch. There are reports of increasing recreational catch, yet estimates of recreational catch are not available for 2022–23. Recreational catch of Pink Ling is known to occur in South Australia, Tasmania, Victoria and New South Wales. Catch is uncertain in South Australia, with estimates of 430 ling (family Ophidiidae) caught by line in 2019–20 (Beckmann et al. 2023). In Tasmania, catch is uncertain, with estimates of fewer than 1,000 ling (*Genypterus* spp.) caught by line in 2017–18 (Lyle et al. 2019). Catch is unknown from Victoria. Surveys of the catches in NSW by NSW-resident recreational fishers during 2013/14 and by 1-3 year licence holders in 2017/18 and 2019/20 did not detect any catches of Pink Ling (West et al, 2015; Murphy et al. 2020, 2022). Similarly, State-wide operators within the nearshore charter fishery landed two Pink Ling during the 2017/18 survey period (Hughes et al. 2021).

Therefore, catches of Pink Ling by recreational fishers in NSW are negligible, relative to the magnitude of commercial catches. Thus, the omission of recreational catch from the model and Commonwealth assessment has little effect on the assessment outcome of the Pink Ling.

Indigenous

The Commonwealth assessment does not, at present, include estimates of Pink Ling catches by Aboriginal fishers. As for recreational catch, any catches by Aboriginal fishers in recent history are assumed to be negligible, relative to the magnitude of commercial catches.

Illegal, Unregulated and Unreported

The level of Illegal Unregulated and Unreported (IUU) fishing has not been quantified.

Fishing effort information

N/A

Stock Assessment

Stock Assessment Methodology

The assessment for Pink Ling is based on a Commonwealth Tier 1 assessment (AFMA 2017 i.e. a quantitative model-based assessment). Despite the lack of genetic variation found between eastern and western pink ling (Daley et al. 2000; Ward et al. 2001), the differences in biological characteristics and catch-rate trends have led to Pink Ling being assessed as separate stocks east and west of longitude 147°E since 2013. Because of the complexities in controlling catch of the stock, Pink Ling is managed under a harvest strategy that estimates projections of stock response to various levels of catch and the risk of those catches reducing biomass below the limit reference point. This approach is taken while pursuing targets for the western stock and trying to rebuild the eastern stock (Butler et al. 2023).

A Tier 1 assessment was done in 2021 (Cordue 2022) updating catch, discards, CPUE, age and length data. Similar to the 2018 assessments, SERAG identified that the values of natural mortality had greatest influence on estimated stock status for both the eastern and western stocks. SERAG agreed again to use the model-estimated natural mortality from the west as a fixed value in the eastern assessment.

Estimated spawning stock biomass in 2021 was estimated to be 34% of the unfished level for the eastern stock (Figure 2). Estimates of spawning stock biomass for both stocks were highly dependent on values of natural mortality, with biomass ranging from 22% to 36% of the unfished level under high and low values of natural mortality in the east. These estimates led to an RBC of 410 t (95% CI 130-630 t) in the east for the 2022-23 fishing season (Cordue 2022) and 1300 t (95% CI 860–1,800 t) in the west. Projections of stock responses to various constant-catch scenarios (Table 1) suggested that for catches up to 600 t in the east the likelihood that the stock was below the LRP by 2024 or 2031 was 5% or less and time to rebuild to the TRP was more than 34 years.

SERAG recommended that a 3-year MYTAC be set at 1,568 t. SERAG also recommended that the RBC for the eastern stock should not exceed 550 t to allow for a quicker recovery of this stock (AFMA 2022).

Year of most recent assessment:

2021 (Cordue 2022)

Assessment method:

Commonwealth Tier 1, Integrated quantitative stock assessment (AFMA 2017; Commonwealth of Australia 2003, 2017)

Main data inputs:

The 2021 assessment was an update of the 2018 assessment with no significant changes to data inputs other than addition of new data (catch, CPUE, length and age frequencies).

Catch – Commonwealth trawl and non-trawl (autoline) sectors; total NSW commercial catches (other state catches were small, within rounding error and ignored). Catch histories were revised for 2016 to 2018 (compared

to the 2018 assessment) and catches for 2019 and 2020 were added, with catches in 2020 assumed to be the same in 2021 (Cordue 2015, 2022)

Commonwealth discard estimates and landing multipliers were applied to data due to Commonwealth trip limits implemented during 2013 and 2014 (no limit; 50 kg; and 250 kg trip limit) (Cordue 2015, 2022).

Standardised CPUE – Commonwealth trawl sector, including 'period effect' for trip limit periods (Cordue 2015, 2022).

Updated assessment in 2021 removed 'period effect' and included discard ratio to tow by tow data prior to CPUE standardisation (Cordue 2022).

Length-frequency data by fishing method, zone and depth (various years from 1998 Cordue 2015, 2022).

Conditional age–length data by fishing method (various years see Cordue 2015, 2022).

Age frequencies data by fishing method (various years see Cordue 2015, 2022).

Key model structure & assumptions:

Tier 1 – Integrated quantitative stock assessment (AFMA 2017; Commonwealth of Australia 2007)

Sources of uncertainty evaluated:

Model sensitivities were investigated (Cordue 2022) including:

- M=0.2: Reference model with M=0.2
- M=0.23 (Base): Reference model with M=0.23
- Est. M (Ref): The reference model where M is estimated using the posterior from the western assessment
- M=0.28: Reference model with M=0.28
- Unf. M: Reference model but a uniform prior on M
- Period CPUE: Using the trawl CPUE indices where period effects were estimated and M estimated
- Per. M=0.23: As for "Period CPUE" but with M=0.23
- Linkall CPUE: Using the trawl CPUE where all vessels were used as linking vessels and M estimated
- No FIS: The reference model but with no FIS indices or length frequencies

Status Indicators - Limit & Target Reference Levels

Biomass indicator or proxy	Depletion of spawning biomass (model estimated)
Biomass Limit Reference Point	B_{20} (20% of pre-exploitation spawning biomass) B_{20} ($0.2B_0$) – <B_{20}: no targeted fishing, rebuilding strategy will be developed (AFMA 2017)
Biomass Target Reference Point	B_{48} (48% of pre-exploitation spawning biomass)
Fishing mortality indicator or proxy	Fishing mortality (model estimated) Risk of overfishing i.e. low risk of SSB < B_{20} under future catch scenarios run through base case – implied from Butler et al. (2023) (despite catches > RBCs)

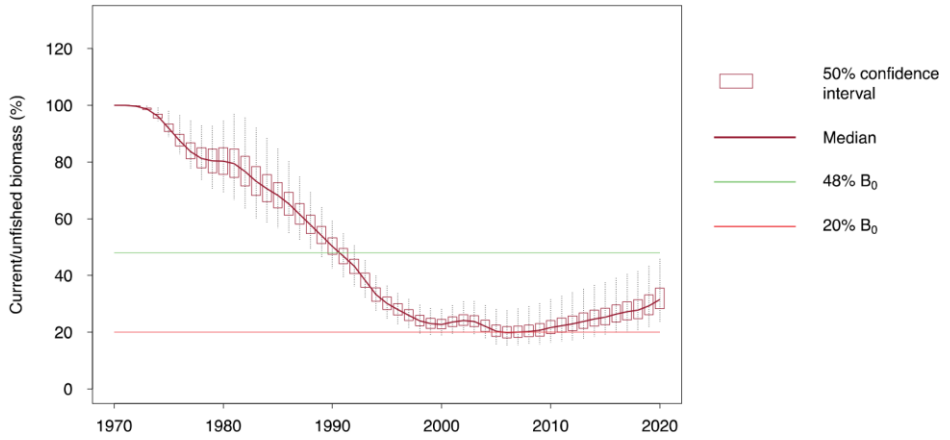
Fishing mortality Limit Reference Point	Not specified within the risk profile outlined (Butler et al. 2023)
Fishing Mortality Target Reference Point	F_{40} (Fishing mortality rate that achieves B_{40})

Stock Assessment Results

Pink Ling (eastern) spawning stock biomass (SSB) estimates from Tier 1 assessment (integrated quantitative stock assessment; AFMA 2017; Commonwealth of Australia 2007, 2017) and predicted biomass as a proportion of unfished biomass (B_0) at constant-catch scenarios with performance indicators (future SSB, probability estimates of being below the limit and year of SSB being at target reference point) are presented in Figure 2.

The 2021 Tier 1 Commonwealth assessment (Cordue 2022) summarised from Butler et al. (2023) states that the spawning stock biomass of Pink Ling (eastern) at the beginning of 2021 is estimated to be 34% ($0.34SB_0$) of the unfished level (SB_0). This was below the target reference point of $0.48SB_0$, but above the limit reference point of $0.20SB_0$ (Figure 2). The eastern stock is, therefore, classified as **not overfished**.

For the 2022-23 fishing season, total combined catch and discards were estimated to be 1,078.5 t, which is below the combined RBC of 1,710 t. The total fishing mortality for eastern Pink Ling was estimated (using the catch ratio from logbooks) to be 551.7 t, which is above the RBC of 410 t from the 2021 assessment. Although total fishing mortality of eastern Pink Ling was above the RBC, the probability of the biomass being depleted to below $0.2B_0$ in 2024 and 2031 at that mortality level (~550 t), is less than 5% (Cordue 2022). Furthermore, the eastern stock is expected to be rebuilt to the target reference point ($0.48SB_0$), with at least a 50% probability before 2050 for catches at 600 t per year or less this level of fishing mortality is unlikely to deplete the eastern stock to a level below its LRP. The stock is, therefore, classified as **not subject to overfishing**.



Note: $\mathbf{B_0}$ Unfished biomass.

Figure 2 Estimated spawning stock biomass for eastern Pink Ling, 1970 to 2020 (Cordue 2022, cited in Butler et al. 2023).

Table 1 Base-case 2021 stock assessment performance indicators for eastern Pink Ling, showing stochastic projections at a range of future constant catches (Cordue 2022).

Annual catch (t)	B_{2024}/B_0	B_{2031}/B_0	Probability $B_{2024} < 0.2B_0$	Probability $B_{2031} < 0.2B_0$	Rebuild year
0	0.47	0.75	0	0	2025
400	0.40	0.51	0	0	2030
475	0.39	0.46	0	0.01	2035
500	0.38	0.45	0.01	0.01	2038
550	0.37	0.42	0.01	0.02	>2055
600	0.36	0.38	0.01	0.05	>2055
650	0.36	0.36	0.02	0.08	Never
700	0.34	0.32	0.03	0.16	Never
750	0.34	0.29	0.04	0.23	Never

Notes: $\mathbf{B_0}$ Unfished biomass. $\mathbf{B_{year}/B_0}$ Predicted biomass ratio in given year. $\mathbf{B_{year} < 0.2B_0}$ Biomass below 20% of B_0 in given year. Rebuild year is the projected year for rebuilding to 48% of B_0.

Stock Assessment Result Summary

Biomass status in relation to Limit	Performance measure above Limit – Spawning stock biomass estimated at $0.20SB_0$ in the 2018 assessment (Cordue 2022, Butler et al. 2023)
Biomass status in relation to Target	Performance measure below Target Reference Point of B_{48} ($0.48SB_0$)
Fishing mortality in relation to Limit	N/A
Fishing mortality in relation to Target	N/A
Current SAFS stock status	Sustainable
Current Commonwealth stock status	Not overfished Not subject to overfishing

Fishery interactions

There are interactions between the Commonwealth Trawl and Auto Lining Fisheries and other commercially fished, by-catch and other species, including threatened and endangered species. Various management and mitigation measures are in place to address many of these issues (AFMA 2018)

The Commonwealth Trawl Fishery interacts with other commercial and non-commercial bycatch and discard marine species, a range of endangered threatened and/or protected species and marine habitats (Wayte et al. 2007).

Stakeholder engagement

N/A

Qualifying Comments

Supplementary information relevant for to the interpretation of the assessment is provided in Appendix 1, 2 and 3.

References

AFMA (Australian Fisheries Management Authority), 2017. Harvest Strategy Framework for the Southern and Eastern Scalefish and Shark Fishery 2009 (amended March 2017). Australian Fisheries Management Authority, Canberra. www.afma.gov.au/wp-content/uploads/2017/03/SESSF-Harvest-Strategy-Framework-2017-final.pdf

AFMA (Australian Fisheries Management Authority), 2022. Southern and Eastern Scalefish and Shark Fishery species summaries 2022, Australian Fisheries Management Authority, Canberra

Althaus, F, Sutton, C and Cannard, T 2022. Southern and Eastern Scalefish and Shark Fishery catches and discards for TAC purposes using data until 2021, CSIRO Oceans and Atmosphere, Hobart.

Beckmann, CL, Durante, LM, Graba-Landry, A, Stark, KE & Tracey, SR 2023, *Survey of recreational fishing in South Australia in 2021–22*, report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide.

Butler, I., Patterson, H., Bromhead, D., Galeano, D., Timmiss, T., Woodhams, J. and Curtotti, R., 2023, Fishery status reports 2023, Australian Bureau of Agricultural and Resource Economics and Sciences, November, Canberra. CC BY 4.0. https://doi.org/10.25814/vgp4-xr81

Commonwealth of Australia, 2007. Commonwealth Fisheries Harvest Strategy Policy. Department of Agriculture and Water Resources, Canberra. www.agriculture.gov.au/SiteCollectionDocuments/fisheries/domestic/hsp.pdf

Cordue, P, 2015. The 2015 stock assessment update for eastern and western pink ling. Innovative Solutions Ltd, Wellington, client report for Australian Fisheries Management Authority (AFMA), Canberra.

Cordue, P, 2018. Pink Ling stock assessment for 2018. Final Report. Innovative Solutions Ltd (ISL) client report for Australian Fisheries Management Authority (AFMA), Canberra.

Cordue, P, 2022, Pink ling stock assessment for 2021: final report, Innovative Solutions Ltd, Wellington, New Zealand.

DAAF, 2007. Commonwealth Fisheries Harvest Strategy: policy and guidelines, Australian Government Department of Agriculture, Fisheries and Forestry, Canberra.

Daley, R., Ward, R., Last, P., Reilly, A., Appleyard, S., and Gledhill, D., 2000. Stock Delineation of pink ling (*Genypterus blacodes*) in Australian waters using genetic and morphometric techniques. Final report, FRDC Project 97/117

Emery, T and Smoothey, AF, 2020. Pink Ling (*Genypterus blacodes*) In: Toby Piddocke, Crispian Ashby, Klaas Hartmann, Alex Hesp, Patrick Hone, Joanne Klemke, Stephen Mayfield, Anthony Roelofs, Thor Saunders, John Stewart, Brent Wise and James Woodhams (eds) 2021, *Status of Australian fish stocks reports 2020*, Fisheries Research and Development Corporation, Canberra.

Hartig, F. (2020). DHARMa: residual diagnostics for hierarchical regression models. Comprehensive R Archive Network.

Hughes, JM, Johnson, D, Murphy, JJ and Ochwada-Doyle, FA, 2021.The NSW Recreational Fisheries Monitoring Program – Charter Fishery Monitoring 2017/18. NSW DPI – Fisheries Final Report Series No. 159. ISSN 2204-8669.pp 97.

Lenth, R., 2020. *emmeans: Estimated Marginal Means, aka Least-Squares Means*. R package version 1.4.5. <https://CRAN.R-project.org/package=emmeans>.

Lyle, JM, Stark, KE, Ewing, GP & Tracey, SR 2019, 2017–18 survey of recreational fishing in Tasmania, Institute for Marine and Antarctic Studies, University of Tasmania.

Morison, A. K., Knuckey, IA, Simpfendorfer, CA and Buckworth, RC, 2013, South East Scalefish and Shark Fishery: draft 2012 stock assessment summaries for species assessed by GABRAG, ShelfRAG & Slope/DeepRAG, report to AFMA, Canberra

Murphy, JJ, Ochwada-Doyle, West, LD, Stark, KE and Hughes, JM, 2020, The NSW Recreational Fisheries Monitoring Program - Survey of recreational fishing, 2017/18. NSW DPI - Fisheries Final Report Series No. 158.

Murphy, J.J., Ochwada-Doyle, F.A., West, L.D., Stark, K.E., Hughes, J.M. and Taylor, M 2022. Survey of recreational fishing in NSW, 2019/20 – Key Results. NSW DPI - Fisheries Final Report Series No. 161.

Ward, R. D., Appleyard, S. A., Daley, R. K. and Reilly, A, 2001. Population structure of Pink Ling (*Genypterus blacodes*) from south-eastern Australian waters, inferred from allozyme and microsatellite analyses, Marine and Freshwater Research, 52: 965–973.

Wayte, S., Dowdney, J., Williams, A., Bulman, C., Sporcic, M., Fuller, M. and Smith, A, 2007. Ecological Risk Assessment for the Effects of Fishing: Report for the otter trawl sub-fishery of the Commonwealth trawl sector of the Southern and Eastern Scalefish and Shark Fishery. Report for the Australian Fisheries Management Authority, Canberra.

West, L. D., Stark, K. E., Murphy, J. J., Lyle, J. M., and F. A. Ochwada-Doyle, 2015 Survey of recreational fishing in New South Wales and the ACT, 2013/14. Fisheries Final Report Series No. 149. NSW Department of Primary Industries, Wollongong.

Appendices

Appendix 1 – Reliability and Relevance of the Commonwealth Assessment to assessment of stock status in NSW

The current Commonwealth assessment of Pink Ling could adequately inform the decision process for an NSW TAC determination, given that the stock of eastern Pink Ling fished in Commonwealth and State jurisdictions is considered a single biological stock, it is reasonable that NSW use the Commonwealth assessment as the basis for determining stock status in NSW. Further, the commercial landings data used in the model include landings data from NSW.

The benefits of adopting Commonwealth assessments include the application of processes exposed to broad review, including by management, science and industry representatives within the Commonwealth fishing sector, as well as observers from other stakeholder groups (e.g. NSW DPI Fisheries). The Commonwealth assessments have not, however, been developed to provide specific outputs for jurisdictions other than the Commonwealth and do not necessarily include or apply data at resolutions more applicable to alternate jurisdictions. Therefore, applying these assessments to inform NSW total allowable catch (TAC) determinations is done understanding that there are limitations in the data used and the application of the data to a scale other than that to which the assessment was applied.

In addition, applying the assessment of Pink Ling from the Commonwealth to inform the status of NSW Pink Ling and reliably inform management decisions for this species assumes (among other issues) that the assessment represents the same population(s) being harvested by these fisheries. Support for this assumption is provided by the 2020 and 2023 determination of the stock structure of Pink Ling for the SAFS reports as a biological stock at the scale of eastern Australia (Emery et al. 2020), including Commonwealth waters to which the Commonwealth assessment applies and NSW waters.

NSW and Commonwealth SESSF catch rates

Annual catch rates were standardised using Generalised Linear Models (GLM) to account for the effects of year, month, authorised fisher and ocean zone on daily data from 2009/10 to 2022/23. Catch rates were standardised for CPUE in kg.day^{-1}. Models were fit using a lognormal distribution, with CPUE as the response variable, and year, month, fisher, and zone as explanatory terms (which were considered categorical variables). Estimated marginal mean values for each year and associated confidence limits were then calculated using the 'emmeans' package (Lenth, 2020) and rforCPUE (Haddon 2023) in R (R Development Team, 2019). Residuals and assumptions of the model were checked using the 'DHARMa' package (Hartig 2020). Using these models, a manual backwards selection process, whereby each variable was removed one at a time and the Akaike information criterion values (AIC) compared between competing models.

Trends in nominal (kg.day^{-1}) and standardised (kg.day^{-1}) catch rates (CPUE) for eastern Pink Ling taken by setline in the Ocean Trap and Line, Line East fishery operating within NSW jurisdiction (Figure 7a, b) are generally consistent with indices of abundance based on spawning stock biomass trends in Commonwealth Trawl Sector and Scalefish Hook Sector (Figure 2). However, there is uncertainty in NSW standardisation and therefore, interpretation should be done with caution because the accuracy of reported hook deployments has not been validated (i.e., large number of fishing trips report the similar number of hooks). Both sources of data, show increasing trends in abundance between 2010 and 2021. This suggests that the component of the stock in NSW waters is exhibiting similar dynamics (with respect to abundance) to the component of stock under Commonwealth jurisdiction and this is consistent with the assumption of a single biological stock.

Appendix 2 - NSW catch statistics and additional information relevant to TAC setting in NSW

The commercial fishery data presented in this section of the report includes total Pink Ling catch landed in NSW from 1976/77 to present and catches reported from the NSW Ocean Trap and Line - Line East (OTLLE) from 2009/10. Information presented in figures and table below is summarised by financial year (July–June). These data are provided as supplementary information to the assessment and to help inform the NSW total allowable catch determination. NSW commercial fishery records have not been consistently reported throughout the history of the fishery. Catch from 1976/77 to 1996/97 (inclusive) includes catch from outside current NSW waters (i.e. Commonwealth catches). Total catch from 1997/98 is restricted to waters in NSW jurisdiction. From 1993 landing Pink Ling was prohibited in the NSW Ocean Trawl Fishery.

State-wide fisheries catch

Annual total catch of Pink Ling demonstrated a substantial increase from the mid-1970s, catches peaked in excess of 500 t in 1984/85 and ~450 t in 1993/94, with a trough in 1988/89 of ~230 t (Figure 1a and b). For three years from 1997/98, reported catches of Pink Ling in NSW were greater than 40 $t.yr^{-1}$. Over the proceeding 9 years, from 2000/01 to 2008/09, annual catches were <25 $t.yr^{-1}$ (range 9.2 t – 24.6 t) and averaged ~16 $t.yr^{-1}$. Between 2008/09 and 2009/10, the total annual catch increased ~25 t to 48.2 t and since 2009/10 annual catches have remained above 40 $t.yr^{-1}$. Since 2009/10, the highest catch of Pink Ling was 68.8 t, landed in 2016/17. Total catch in 2022/23 was 43.2 t (Figure 3). Annual landings of Pink Ling in NSW, on average, are less than 14.6% of the total annual catches landed in the Commonwealth (SESSF Commonwealth Trawl Sector, SESSF Gillnet, Hook and Trap Sector and South East Non-Trawl Fishery, Figure 4).

Pink Ling are landed almost exclusively in the OTLLE endorsement (2009/10-2022/23 ≥ 99.3%, range 40.3-68.5 $t.yr^{-1}$; Figure 5), and within the OTLLE, almost exclusively by the demersal setline fishing method (2009/10-2022/23 average 91.9%; range 30.8-66 $t.yr^{-1}$; Figure 6).

Additional information relevant to TAC setting in NSW

- The Pink Ling TAC for the May 2021-April 2022 fishing season was set at the 8-year maximum catch of 67.7 tonnes.
- Statistics describing landings of Pink Ling from NSW commercial fisheries may inform determination of a NSW TAC that is consistent with the development of an inter-jurisdictional resource sharing policy.
- Landings of 43.2 t were reported against a NSW TAC of 67.7 t in 2022/23.
- 22.78.t (33.6%) of the 2023/24 Pink ling TAC (67.7 t) was taken at 26th November 2023.
- AFMA Management recommends a TAC of 1,565 t for the 2023-24 fishing year, the second year of a 3-year MYTAC, with overcatch and undercatch provisions set at 10 per cent and a determined amount of 2 t. The eastern notional catch limit of 550 t minus state catches (52.5 t) and discards (37 t) is 461 t.

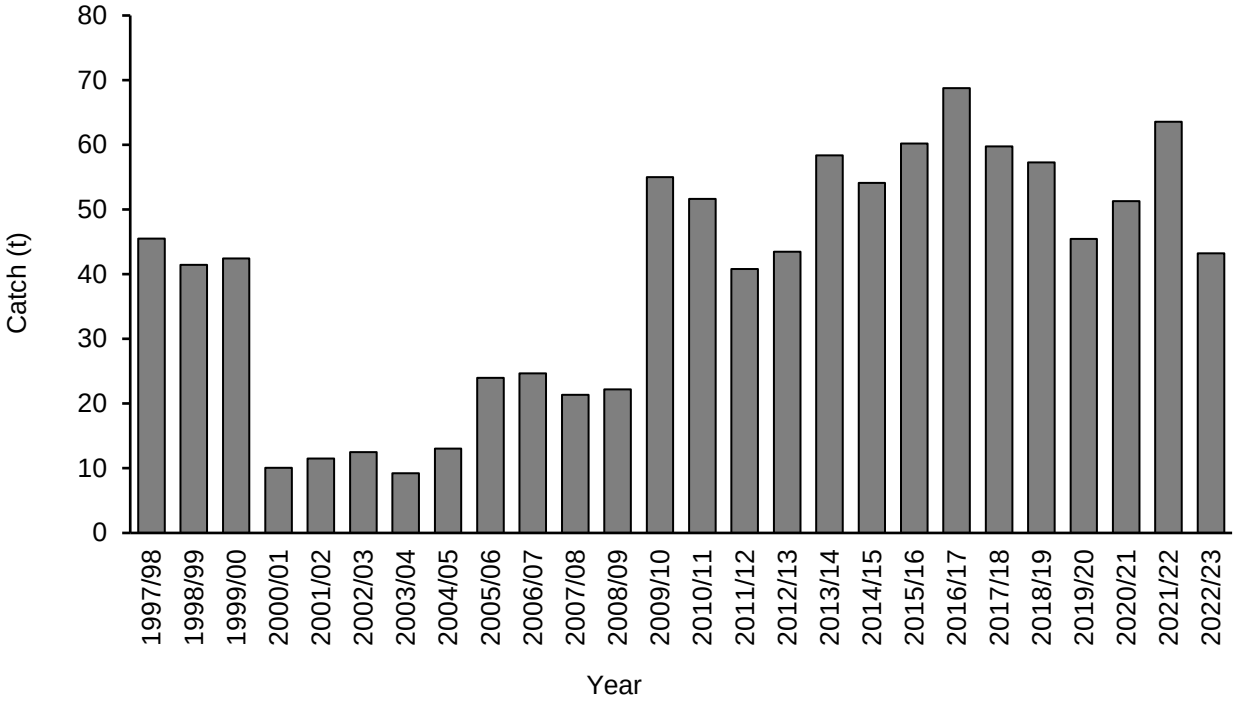


Figure 3 Annual catch (t) of Pink Ling from all fishing methods reported from NSW from 1997/98 to 2022/23.

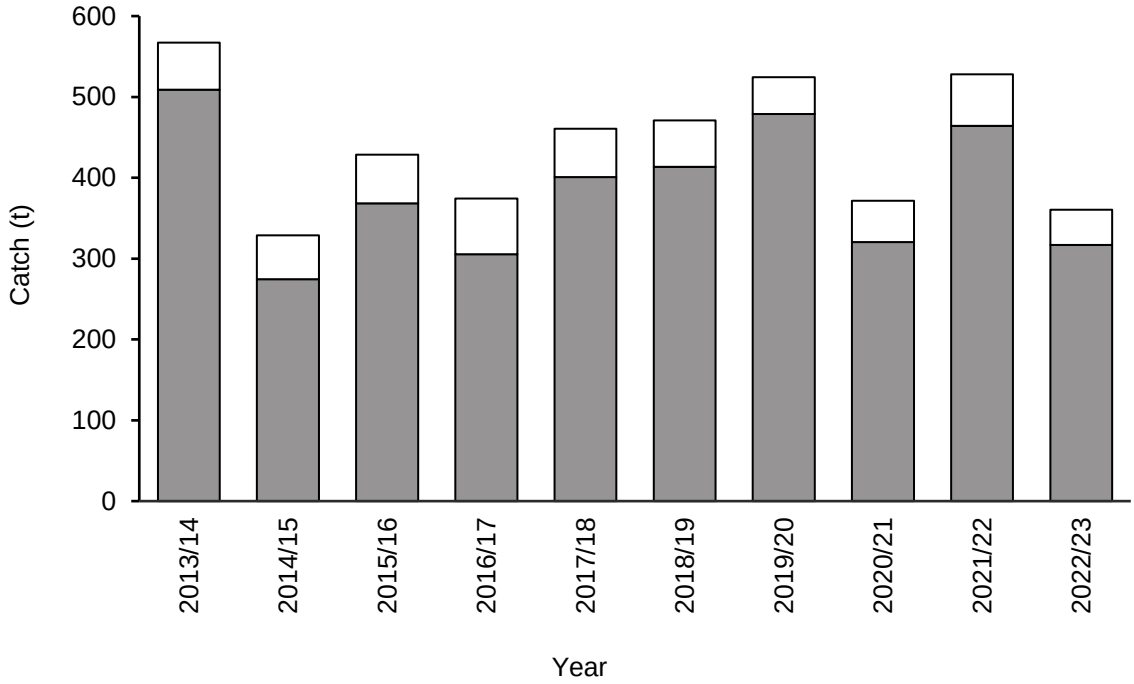


Figure 4 Annual landed catch (t) of the eastern stock of Pink Ling from the Commonwealth (dark grey, SESSF Commonwealth Trawl Sector, SESSF Gillnet, Hook and Trap Sector & South East Non-Trawl Fishery) and all fishing methods reported to NSW (white) from 2013/14 to 2022/23.

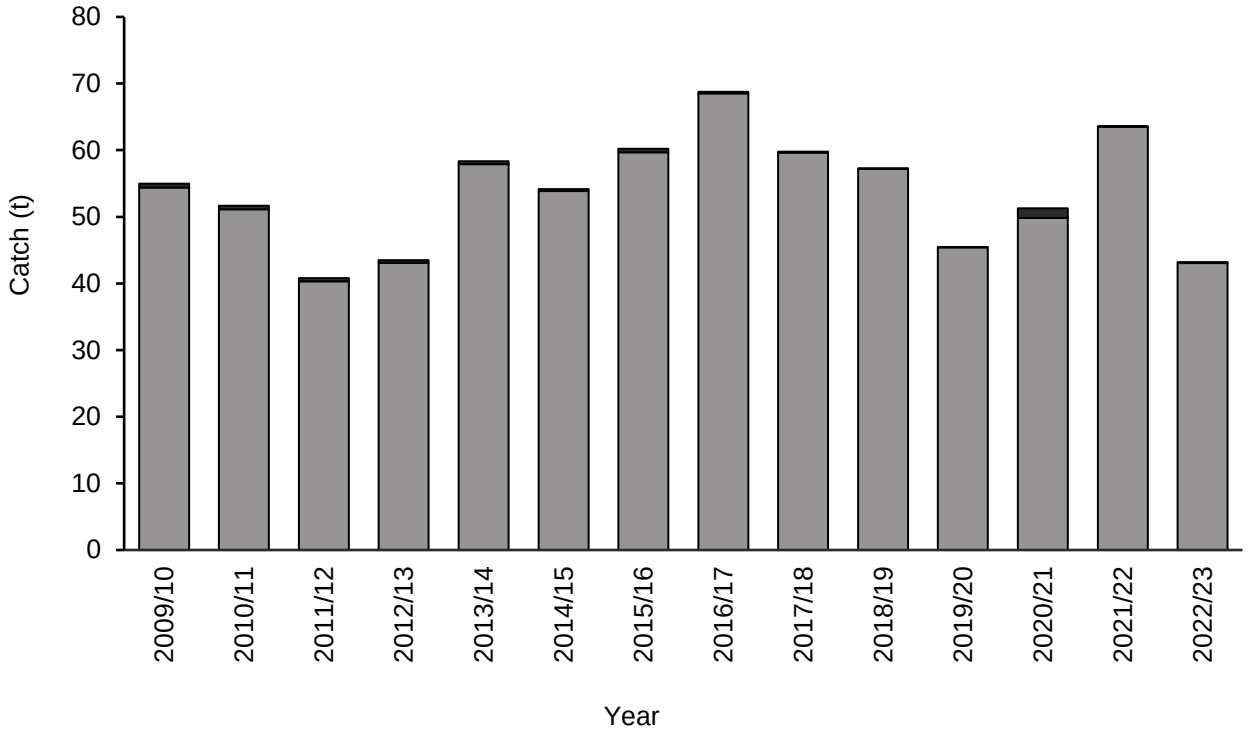


Figure 5 Annual catch (t) of Pink Ling in NSW Ocean Trap and Line - Line East (grey) and all other endorsement codes (black) from 2009/10 to 2022/23.

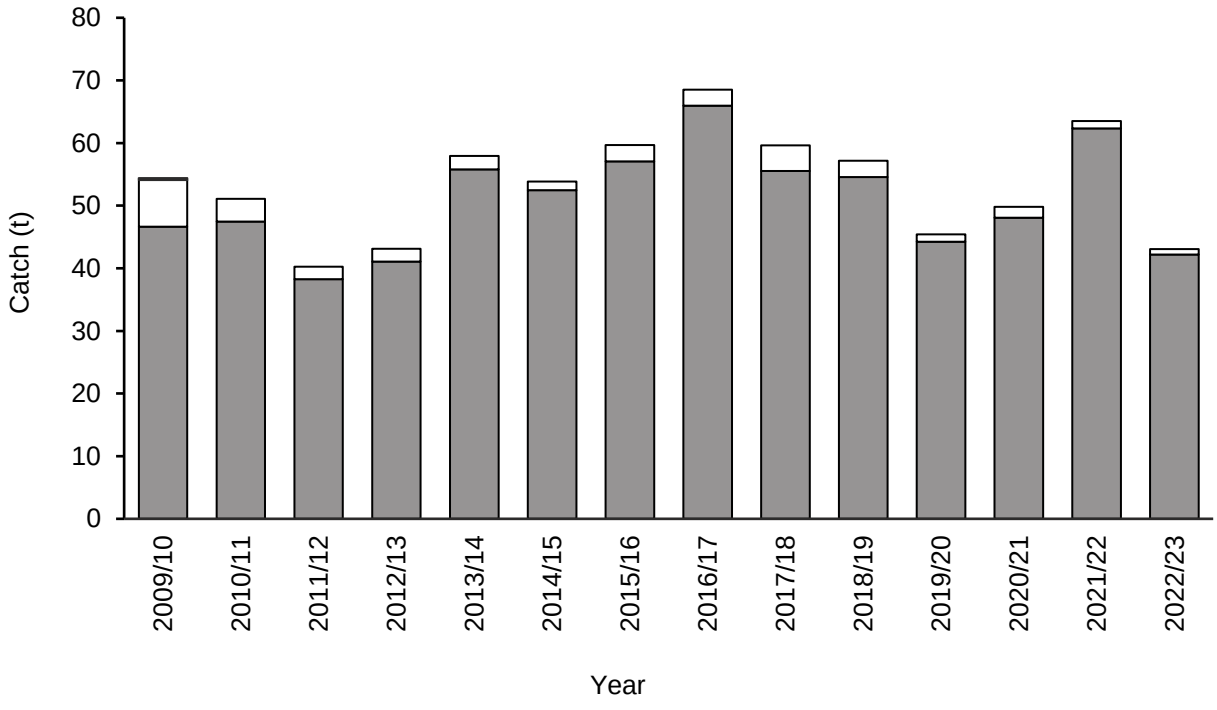
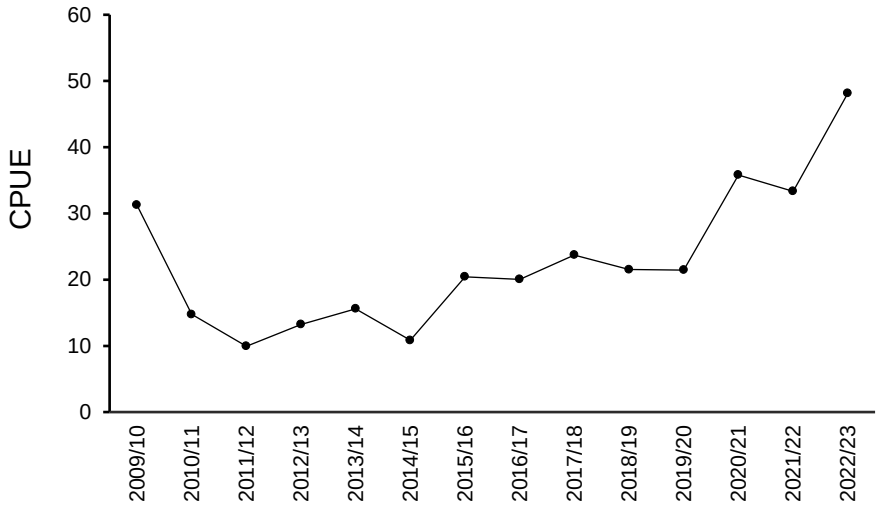


Figure 6 OTLLE – fishing methods - Annual catch (t) of Pink Ling in NSW Ocean Trap and Line - Line East (OTLLE) by setline (grey columns; demersal (STD), trotline (TTL) and unspecified setline (ST)), dropline (white columns; DPL), and other methods (black columns) from 2009/10 to 2022/23.

(a)



(b)

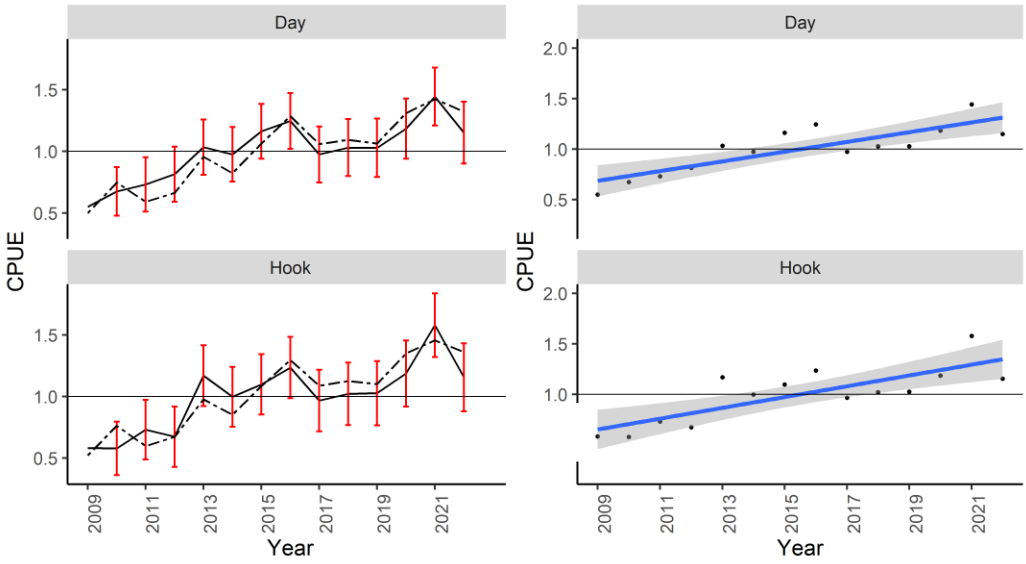


Figure 7 (a) Nominal commercial catch rates (CPUE kg.day^{-1}) of Pink Ling for the method of demersal setline from 2009/10 to 2022/23 and (b) standardised commercial catch rates (CPUE kg.hook^{-1} and CPUE kg.day^{-1}, solid blackline line with red error bars) of Pink Ling for the method of demersal setline.

Appendix 3 – Model selection and diagnostic plots for dropline CPUE standardisation

Table 2 Selection of model terms for standardisation of dropline CPUE (2009/10 to 2022/23). AIC: Akaike's Information Criterion.

	AIC
Year + Month + Fishing Business + Ocean Zone	4614.945
Year + Month + Fishing Business	4643.248
Year + Month + Ocean Zone	5114.685
Year + Fishing Business + Ocean Zone	4760.432
Year + Month	5287.118
Year + Fishing Business	4792.492

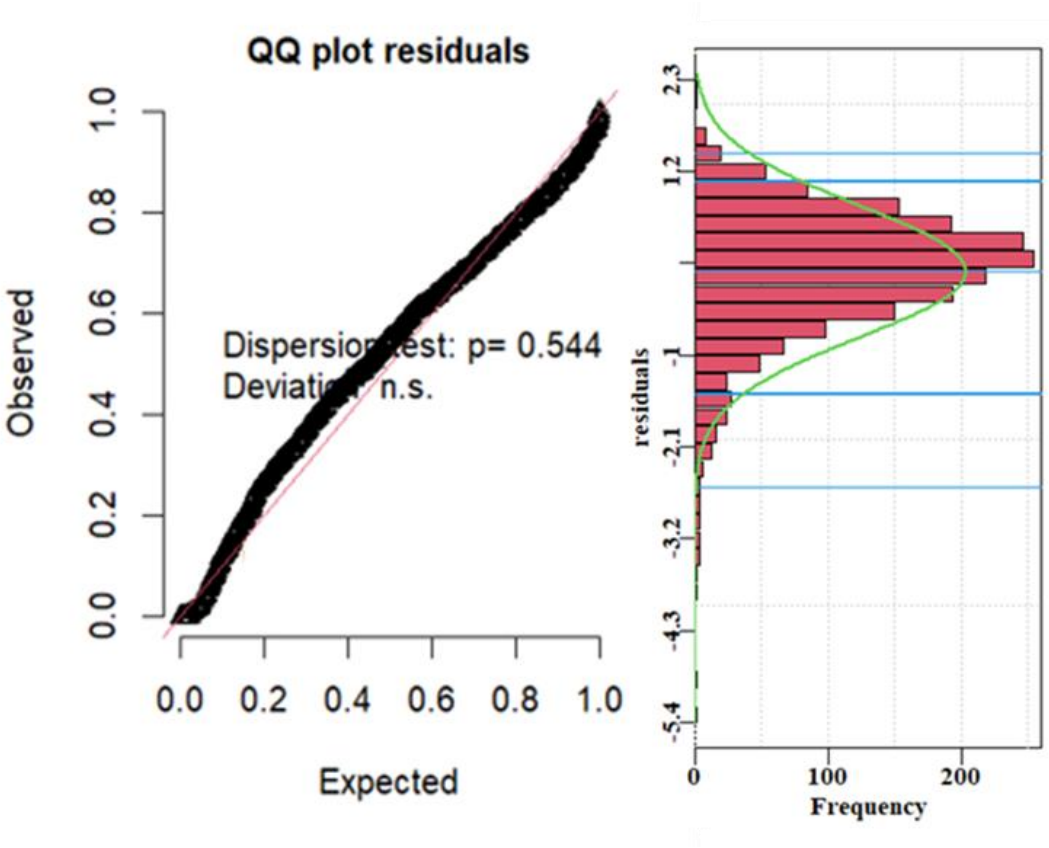


Figure 8 Distribution of residuals relative to expected normality for the CPUE standardisation model (2009/10 to 2022/2023).

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