# Preliminary standardized catch rates of mutton snapper from the United States Gulf of Mexico and South Atlantic commercial handline and longline fisheries, 1993-2022

Sustainable Fisheries Branch

SEDAR79-DW-08

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# Preliminary standardized catch rates of mutton snapper from the United States Gulf of Mexico and South Atlantic commercial handline and longline fisheries, 1993-2022

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June 2023*

Updated August 2023

This document describes the development of the SEDAR 79 commercial logbook indices for mutton snapper. Initial mutton snapper indices of abundance were constructed through 2006 during SEDAR 15A (SEDAR 15A-DW-00) and updated through 2012 for the recent SEDAR 15A update assessment.

Since the SEDAR 15A update, additional exploratory analyses have been developed conducted for both Gulf of Mexico and South Atlantic stocks to better evaluate the potential utility of fishery dependent indices in regional stock assessments given recent increases in regulatory management actions. Fishery dependent indices are often scrutinized during the SEDAR review process, leading to calls for more detailed analyses to ensure these data are reflecting trends in abundance, as opposed to reflecting other changes that may be occurring in the fishery (regulations, fleet behavior). Examples of the impact of management regulations on the ability of fishery dependent indices to track population abundance have been discussed in previous South Atlantic assessments for tilefish (SEDAR66WP03), snowy grouper (SEDAR36WP03), and blueline tilefish (SEDAR50WP26). Several contributing factors led to the recommendation not to use the indices developed for these assessments (increased regulations, closures, targeting hyperstability, etc.), many of which (including a limited spatial range) are also a concern for the mutton snapper index developed in this working paper.

## Commercial Fisheries Logbook Program (CFLP) overview

Landings and fishing effort of commercial vessels operating in the Gulf of Mexico and southeast U.S. Atlantic are monitored by the NMFS Southeast Fisheries Science Center through the Coastal Fisheries Logbook Program (CFLP). The program collects trip-level information from all vessels holding federal permits to fish in waters managed by the regional Fishery Management Councils. Initiated in the Gulf in 1990, the CFLP began collecting logbooks from Atlantic commercial fishers in 1992, when 20% of Florida vessels were targeted. Beginning in 1993, sampling in Florida was increased to require reports from all vessels permitted in coastal

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*This document has been updated as of August 2023 to reflect a minor fix to the subsetting procedure for the handline index. The update resulted in very minor changes to the index.

fisheries, and since then has maintained the objective of a complete census of federally permitted vessels in the southeast U.S.

For each fishing trip, the CFLP database included a unique trip identifier, the landing date, fishing gear deployed, areas fished, number of days at sea, number of crew, gear-specific fishing effort, species caught, and weight of the landings. Fishing effort data available for vertical line gear (manual and electric) included number of lines fished, hours fished, and number of hooks per line.

## Background

The commercial logbook data for the handline and longline fishery were examined to determine the potential utility of these indices in the SEDAR 79 mutton snapper stock assessment. In particular, we explored the need for additional filters on specific strata and truncation of available CFLP data to account for the potential impacts of new management regulations: 1. Seasonal closures to avoid fishing during spawning season (temporal restriction) 2. Establishment of mutton snapper ACLs in 2012 (changes in species targeting) 3. Indirect effects of regulations on other snapper-grouper species (e.g., possible effects of IFQ in Gulf of Mexico). 4. Spatial restrictions on allowable fishing gears (shifts in behavior).

## Data Description

Catch per unit effort (CPUE), defined as whole weight per hook hour (handline) and whole weight per number of sets by the number of hooks per set (for longline), from the logbooks was used to develop an index of abundance for mutton snapper landed with handlines (manual handline and electric reel) or longline gear. Thus, the size and age range of fish included in the index is the same as that of landings from these two fleets.

1. Outlier removal

Extreme values occur more frequently in self-reported data because there are limited opportunities to validate data. Recent SEDAR stock assessments have removed values at the extreme upper tail of the distribution for CPUE and associated fields in self-reported fishery-dependent data. Values falling outside the 99.5 percentile of the data were excluded from the analyses.

2. Data exclusions and assumptions (delayed reporting, multiple gears, area reported)

Data were restricted to include only those trips with landings and effort data reported within 45 days of the completion of the trip to minimize the potential for recall bias (some reporting delays were longer than one year). Also excluded were trips that reported use of multiple gears fished, which prevents designating trip-level catch and effort records to specific gears. Therefore, only trips which reported one gear fished were included in these analyses. For trips that reported fishing in more than one area, the first area reported was used to determine the latitude associated with the trip.

3. Starting year

Implemented in 1992, the CFLP did not require reporting from all Gulf of Mexico and US Atlantic commercial fishermen until 1993. Therefore, 1993 was chosen as the starting year for the constructed indices.

4.Terminal year - spawning closure, commercial closures for other snapper-grouper species, spatial closures, ACLs

Regulations on mutton snapper fishing in both regions vary widely and were examined for this working paper, but a comprehensive discussion is necessary at the data workshop to determine if extending these indices past 2011 (2012 reduction in ACLs) would actually reflect changes in abundance as opposed to changes in fishing behavior.

**Topics to discuss at DW**

- Shift from a year-round fishery to include seasonal closures: May-June closure established in 1992 and Apr-June closure in 2018. Depending on terminal year determination, possible need to exclude April data from index development
- Coastal logbook data are trip-based, therefore, effort (specifically hours fished) cannot be unambiguously apportioned if targeting changed during a trip.
- Spatially limited fishery primarily (depth restrictions)
- Trip and size limits (2018)
- Reduction in ACLs, which were first established in 2012
- Potential shifts in desirability due to IFQ implementation, targeting of mutton maybe have changed

## Evaluation of explanatory variables

YEAR – Year was necessarily included, as standardized catch rates by year are the desired outcome. Years modeled were 1993-2022.

SEASON – Season included two levels: summer and fall.

AREA – Area included two levels: South Atlantic region and Gulf of Mexico for handline, 2 subregions for the longline fleet in the Gulf of Mexico

DAYS AT SEA – Days at sea (sea days) were pooled into three levels: one day (one), two to four days (twotofour), and five or more days (fiveplus).

CREW SIZE – Crew size (includes Captain) was pooled into three levels;1, 2, and 3 plus crew per trip.

## Analytical decisions

1. Subsetting trips - Use Stephens and MacCall(2004) method
2. Species included in Stephens and MacCall approach: limit to snapper-grouper complex and remove species with full-year closures, ID issue, or large shifts in desirability over the index period

3. Apply Stephens and MacCall to the two regions for handline and longline

## Subsetting trips

Effective effort was based on those trips from areas where mutton snapper were available to be caught. Without fine-scale geographic information on fishing location, trips to be included in the analysis must be inferred, which was done here using the method of Stephens and MacCall (2004). The method uses multiple logistic regression to estimate a probability for each trip that the focal species was caught, given other species caught on that trip. The method was applied separately for the two regions considered due to species composition shifts.

A backwards stepwise AIC procedure (Venables and Ripley 1997) was then used to perform further selection among possible species as predictor variables, where the most general model included all listed species as main effects. In this procedure, a generalized linear model with Bernoulli response was used to relate presence/absence of mutton snapper in each trip to presence/absence of other species. A trip was then included if its associated probability of catching mutton snapper was higher than a threshold probability. The threshold was designed to be that which resulted in the same number of predicted and observed positive trips, as suggested by Stephens and MacCall (2004).

## Standardization

CPUE was modeled using the delta-GLM approach (Lo, Jacobson, and Squire 1992; Dick 2004; Maunder and Punt 2004). This approach combines two separate generalized linear models (GLMs), one to describe presence/absence of the focal species, and one to describe catch rates of successful trips (trips that caught the focal species). Estimates of variance were based on 1000 bootstrap runs where trips were chosen randomly with replacement (Efron and Tibshirani 1993). All analyses were programmed in R, with much of the code adapted from Dick (2004).

## Bernoulli submodel

The Bernoulli component of the delta-GLM is a logistic regression model designed to predict the presence/absence (i.e., availability to be caught) of mutton snapper on any given trip. Initially, all explanatory variables were included in the model as main effects, and then stepwise AIC (Venables and Ripley 1997) with a backwards selection algorithm was used to eliminate those variables that did not improve model fit. In this case, the stepwise AIC procedure did not remove any explanatory variables. Diagnostics, based on standardized (quantile) residuals, suggested reasonable fits of the Bernoulli submodel.

## Positive CPUE submodel

Two parametric distributions were considered for modeling positive values of CPUE, lognormal and gamma. For both distributions, all explanatory variables were initially included as main effects, and then stepwise AIC (Venables and Ripley 1997) with a backwards selection algorithm was used to eliminate those variables that did not improve model fit. For both distributions, the best model fit included all explanatory variables. The two distributions were compared using AIC. Lognormal outperformed gamma, and was therefore applied in the final delta-GLM. Diagnostics suggested a reasonable fit of the standardization procedure.

## Results

The standardized index was similar to the nominal index for both indices while the diagnostic plots (Tables 1-2 and Figures 1-18) indicate a few issues that may require additional discussion at the data workshop:

- Major shifts pre- and post- 2010 in those (zero-catch) trips retained for both the handline and longline indices suggest that the Stephens and MacCall subsetting method is not identifying effective effort consistently during the time series. This inconsistency stems from a different subset of species being selected from the new CFLP data (updated with recent years), which is believed due to recent management actions that has affected fisher behavior and the comparability of CFLP data across the time series.

- Decrease in the relative number of vessels in the fishery before and after increased regulations indicate a potential shift in the fishery

- An increase in proportion positive that is correlated with the establishment of regional ACLs for mutton snapper

Recommendation:

Upon reviewing the available data and evaluating the resultant CPUE indices, it is believed that these two indices may no longer be reflecting abundance but instead reflecting changes to the fleet and fishery due to increased regulation. A precautionary approach should be used when determining the utility of these two indices following increased regulations on mutton snapper in both regions, particularly after 2010. Findings and discussion from the data workshop will be critical in determining the best use of these data. Final recommendations will be published in the final data workshop report.

Table 1. Standardized index for the mutton snapper commercial handline fishery.

| Year | N | Nominal CPUE | Relative nominal | Standardized CPUE | Proportion Positive | CV |
|---|---|---|---|---|---|---|
| 1993 | 766 | 0.16 | 0.99 | 0.69 | 0.31 | 0.10 |
| 1994 | 1238 | 0.12 | 0.79 | 0.70 | 0.32 | 0.07 |
| 1995 | 1462 | 0.11 | 0.68 | 0.62 | 0.28 | 0.08 |
| 1996 | 1321 | 0.12 | 0.75 | 0.62 | 0.26 | 0.08 |
| 1997 | 1612 | 0.13 | 0.81 | 0.73 | 0.30 | 0.07 |
| 1998 | 1358 | 0.12 | 0.78 | 0.71 | 0.27 | 0.08 |
| 1999 | 1211 | 0.12 | 0.74 | 0.84 | 0.27 | 0.08 |
| 2000 | 1190 | 0.13 | 0.82 | 0.79 | 0.29 | 0.08 |
| 2001 | 1255 | 0.14 | 0.89 | 0.82 | 0.29 | 0.08 |
| 2002 | 1409 | 0.17 | 1.06 | 0.98 | 0.32 | 0.07 |
| 2003 | 1286 | 0.19 | 1.17 | 1.08 | 0.30 | 0.08 |
| 2004 | 1294 | 0.18 | 1.11 | 1.07 | 0.31 | 0.07 |
| 2005 | 1061 | 0.15 | 0.93 | 1.01 | 0.32 | 0.08 |
| 2006 | 912 | 0.16 | 1.01 | 0.92 | 0.31 | 0.09 |
| 2007 | 850 | 0.14 | 0.88 | 0.88 | 0.30 | 0.09 |
| 2008 | 748 | 0.13 | 0.83 | 0.74 | 0.26 | 0.10 |
| 2009 | 585 | 0.17 | 1.09 | 0.86 | 0.28 | 0.12 |
| 2010 | 458 | 0.18 | 1.13 | 0.92 | 0.28 | 0.12 |
| 2011 | 554 | 0.14 | 0.90 | 0.79 | 0.29 | 0.11 |
| 2012 | 435 | 0.19 | 1.17 | 1.43 | 0.30 | 0.12 |
| 2013 | 399 | 0.18 | 1.13 | 1.37 | 0.32 | 0.13 |
| 2014 | 624 | 0.17 | 1.04 | 1.17 | 0.29 | 0.10 |
| 2015 | 529 | 0.21 | 1.29 | 1.47 | 0.38 | 0.11 |
| 2016 | 535 | 0.14 | 0.86 | 0.88 | 0.28 | 0.11 |
| 2017 | 443 | 0.18 | 1.12 | 1.09 | 0.31 | 0.11 |
| 2018 | 364 | 0.18 | 1.11 | 1.18 | 0.34 | 0.13 |
| 2019 | 362 | 0.22 | 1.39 | 1.38 | 0.36 | 0.12 |
| 2020 | 367 | 0.21 | 1.31 | 1.32 | 0.50 | 0.10 |
| 2021 | 275 | 0.16 | 1.03 | 1.49 | 0.47 | 0.13 |
| 2022 | 219 | 0.19 | 1.18 | 1.46 | 0.42 | 0.14 |

Table 2. Standardized index for the mutton snapper commercial longline fishery.

| Year | N | Nominal CPUE | Relative nominal | Standardized CPUE | Proportion Positive | CV |
|---|---|---|---|---|---|---|
| 1993 | 121 | 0.005 | 0.91 | 0.41 | 0.53 | 0.28 |
| 1994 | 105 | 0.005 | 0.98 | 0.53 | 0.53 | 0.30 |
| 1995 | 130 | 0.006 | 1.04 | 0.86 | 0.53 | 0.23 |
| 1996 | 185 | 0.004 | 0.79 | 0.48 | 0.48 | 0.23 |
| 1997 | 222 | 0.006 | 1.17 | 0.65 | 0.53 | 0.21 |
| 1998 | 203 | 0.005 | 0.92 | 0.55 | 0.55 | 0.24 |
| 1999 | 129 | 0.006 | 1.06 | 0.61 | 0.53 | 0.27 |
| 2000 | 129 | 0.005 | 0.84 | 0.55 | 0.44 | 0.26 |
| 2001 | 151 | 0.005 | 0.99 | 0.77 | 0.52 | 0.24 |
| 2002 | 103 | 0.007 | 1.29 | 1.39 | 0.53 | 0.26 |
| 2003 | 167 | 0.006 | 1.04 | 1.08 | 0.49 | 0.23 |
| 2004 | 171 | 0.008 | 1.45 | 1.34 | 0.44 | 0.23 |
| 2005 | 185 | 0.008 | 1.39 | 1.30 | 0.54 | 0.22 |
| 2006 | 185 | 0.007 | 1.34 | 1.38 | 0.51 | 0.21 |
| 2007 | 153 | 0.007 | 1.24 | 1.06 | 0.54 | 0.26 |
| 2008 | 155 | 0.005 | 0.92 | 0.80 | 0.49 | 0.26 |
| 2009 | 75 | 0.007 | 1.23 | 0.99 | 0.56 | 0.28 |
| 2010 | 62 | 0.005 | 0.92 | 0.93 | 0.58 | 0.30 |
| 2011 | 101 | 0.006 | 1.03 | 1.00 | 0.56 | 0.27 |
| 2012 | 128 | 0.005 | 0.92 | 0.75 | 0.35 | 0.33 |
| 2013 | 81 | 0.005 | 1.00 | 1.83 | 0.38 | 0.34 |
| 2014 | 77 | 0.005 | 0.89 | 1.22 | 0.36 | 0.42 |
| 2015 | 83 | 0.003 | 0.47 | 0.88 | 0.41 | 0.33 |
| 2016 | 115 | 0.004 | 0.74 | 0.96 | 0.52 | 0.22 |
| 2017 | 149 | 0.005 | 1.00 | 1.51 | 0.54 | 0.25 |
| 2018 | 121 | 0.005 | 1.01 | 1.07 | 0.60 | 0.25 |
| 2019 | 83 | 0.002 | 0.44 | 0.71 | 0.51 | 0.29 |
| 2020 | 94 | 0.005 | 0.88 | 0.93 | 0.59 | 0.22 |
| 2021 | 86 | 0.004 | 0.77 | 1.24 | 0.58 | 0.24 |
| 2022 | 82 | 0.007 | 1.35 | 2.21 | 0.66 | 0.23 |

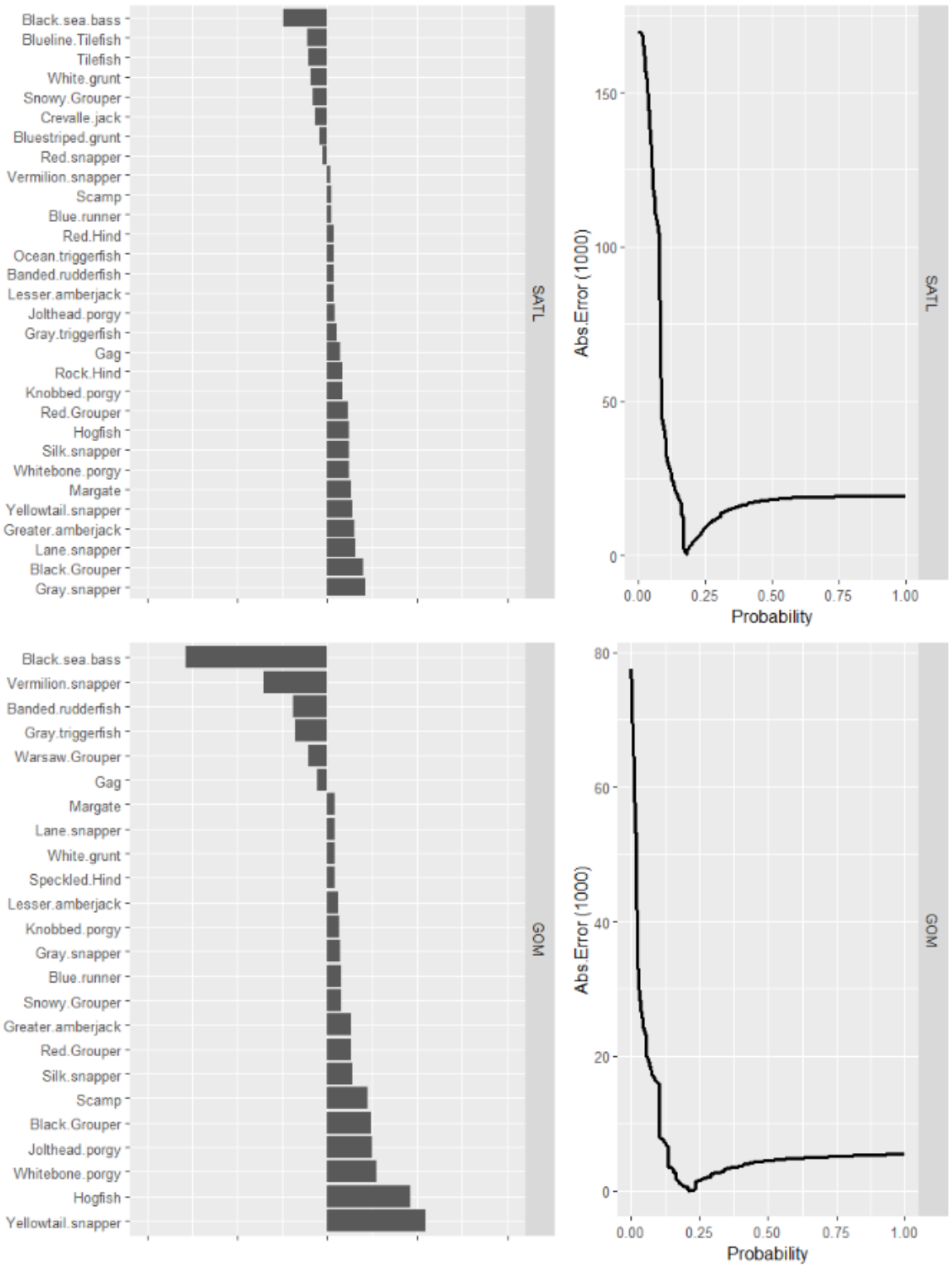


Figure 1. Estimates (commercial handline) of species-specific regression coefficients used to predict each trip's probability of catching the focal species on the left panel. The right panel shows the absolute difference between observed and predicted number of positive trips across a range of probability cutoff values.

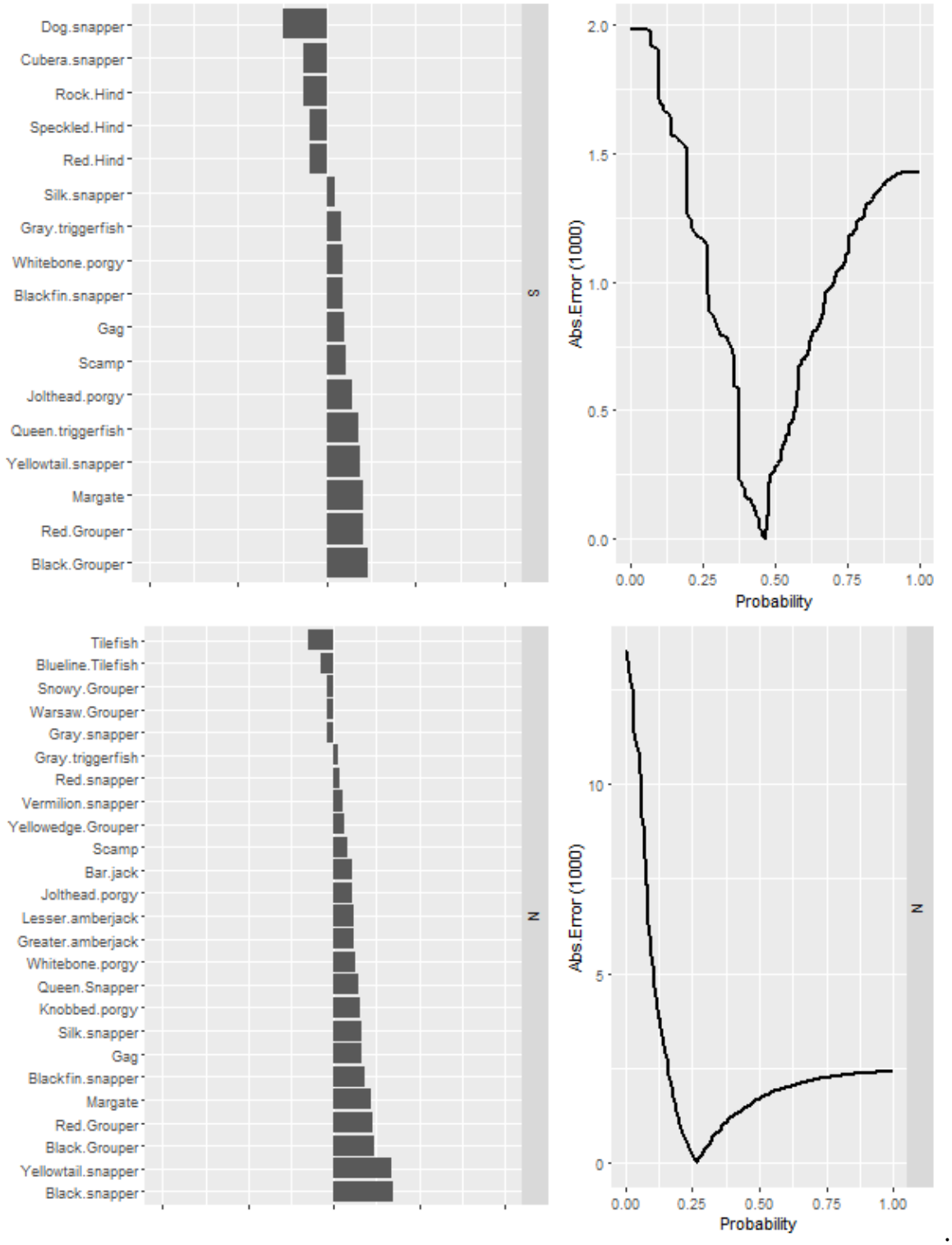


Figure 2. Estimates (commercial longline) of species-specific regression coefficients used to predict each trip's probability of catching the focal species on the left panel. The right panel shows the absolute difference between observed and predicted number of positive trips across a range of probability cutoff values.

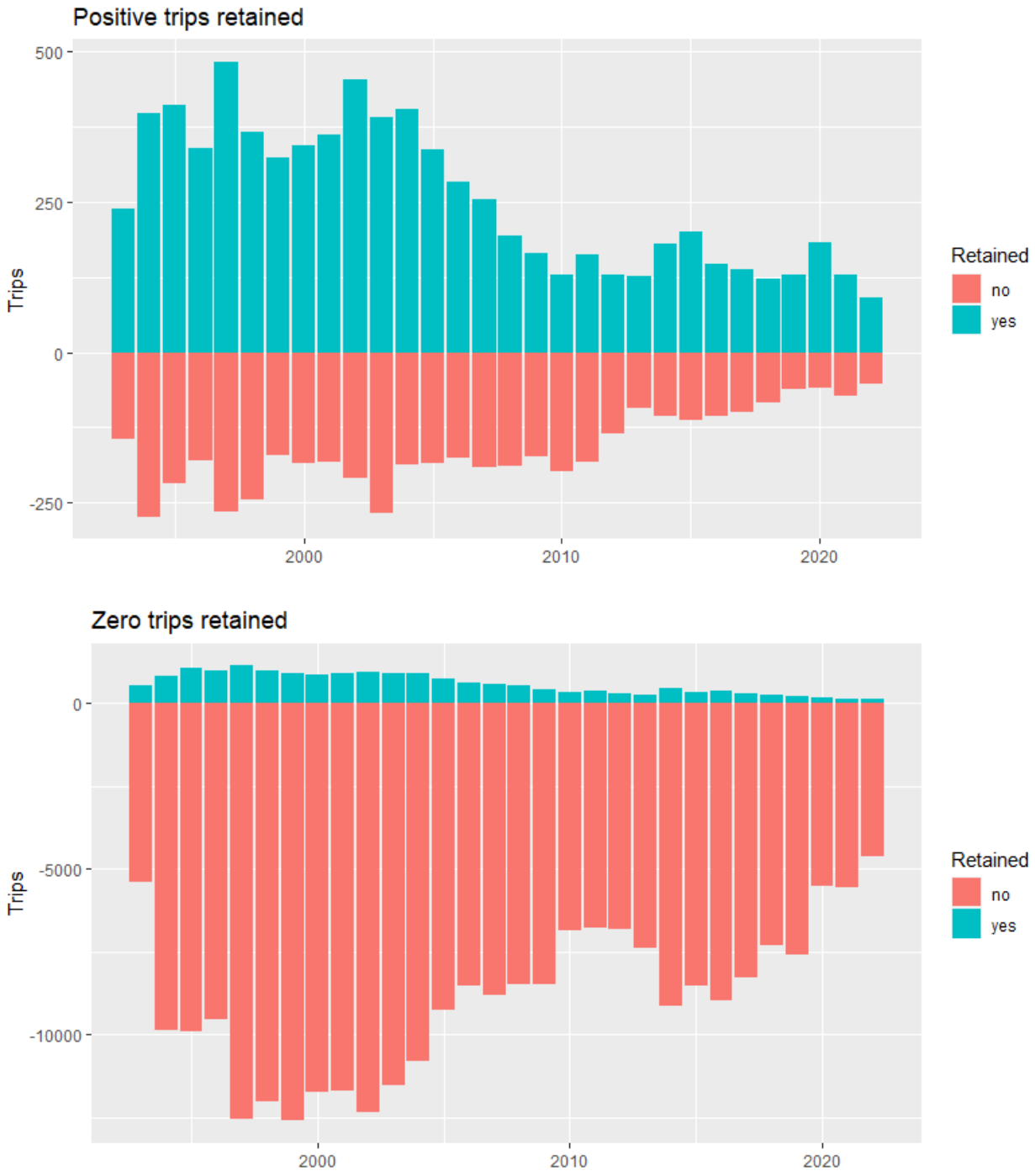


Figure 3. Positive and zero trips retained after subsetting using Stephens and MacCall approach by year for mutton snapper (commercial handline).


Figure 4. Positive and zero trips retained after subsetting using Stephens and MacCall approach by year for mutton snapper (commercial longline).

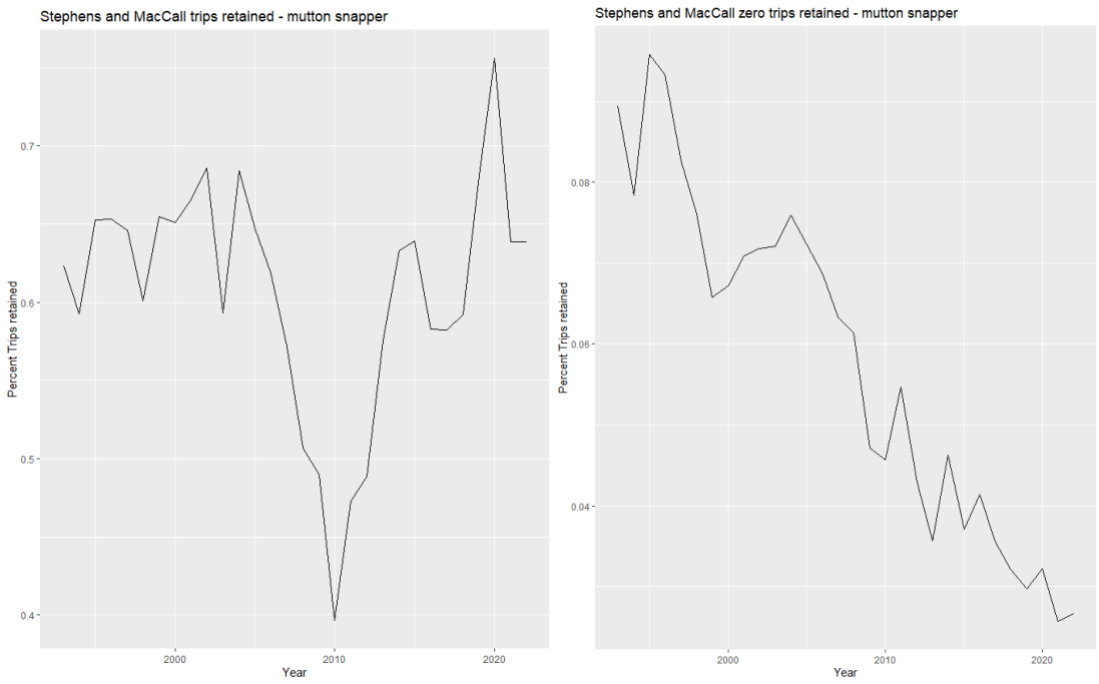


Figure 5. Proportion of positive (left) and zero (right) trips retained by year after subsetting using Stephens and MacCall approach (commercial handline).

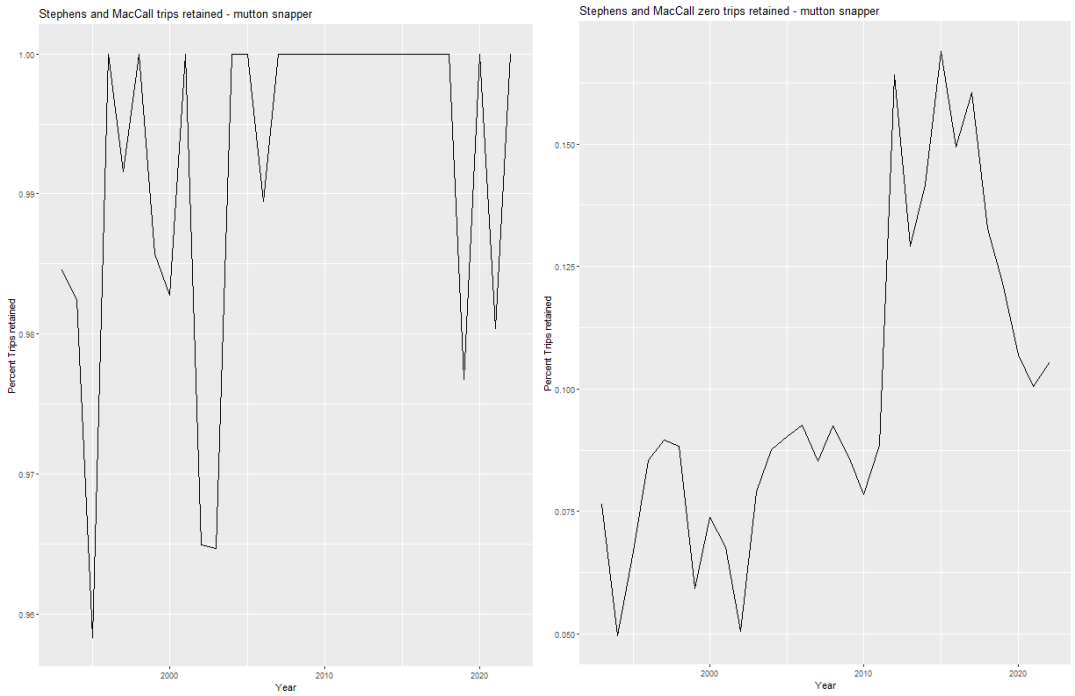


Figure 6. Proportion of positive (left) and zero (right) trips retained by year after subsetting using Stephens and MacCall approach (commercial longline).


Figure 7. Positive and zero trips retained by region and month after subsetting using Stephens and MacCall approach (commercial handline).

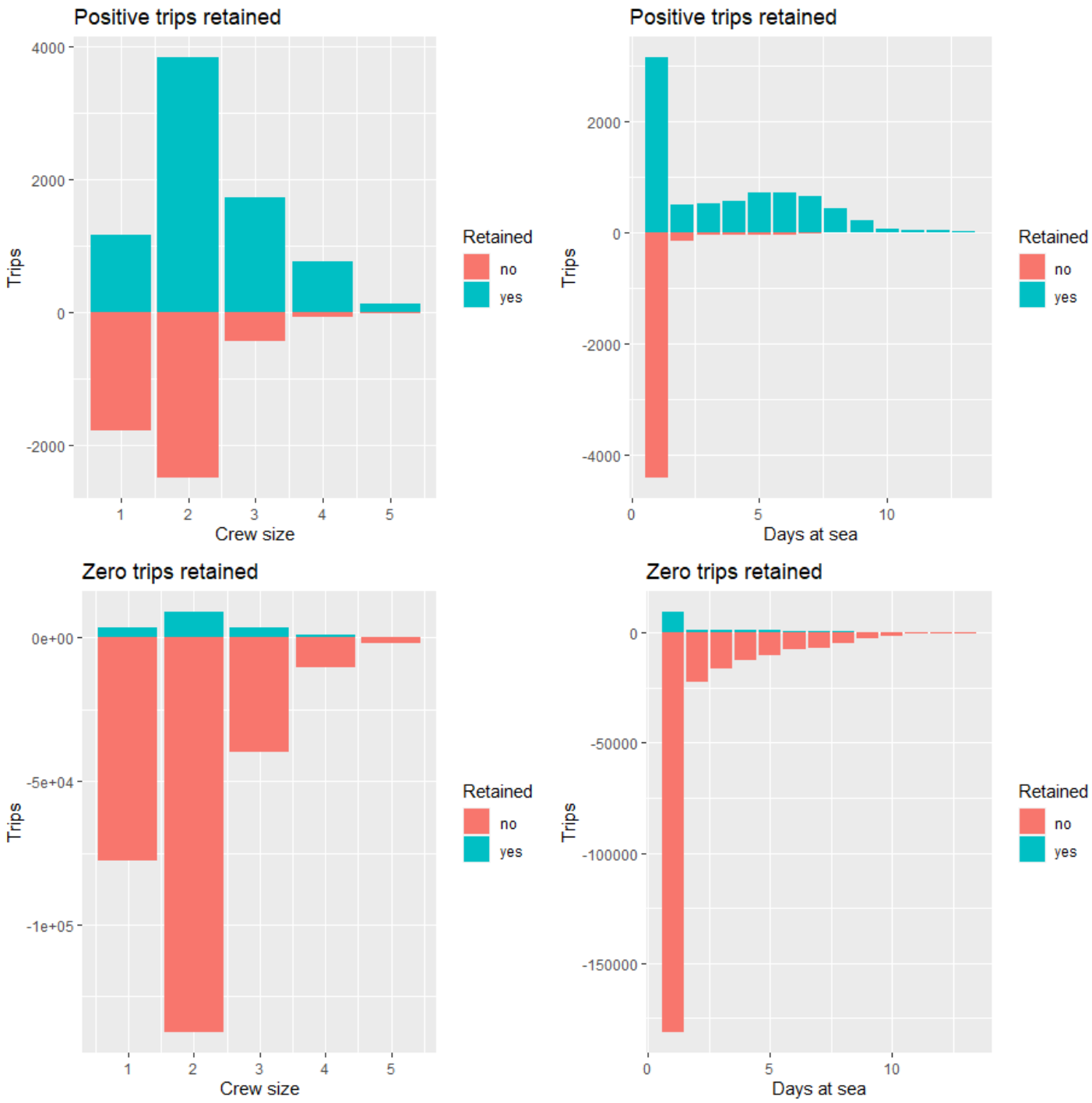


Figure 8. Positive and zero trips retained by crew size and days at sea after subsetting using Stephens and MacCall approach (commercial handline).

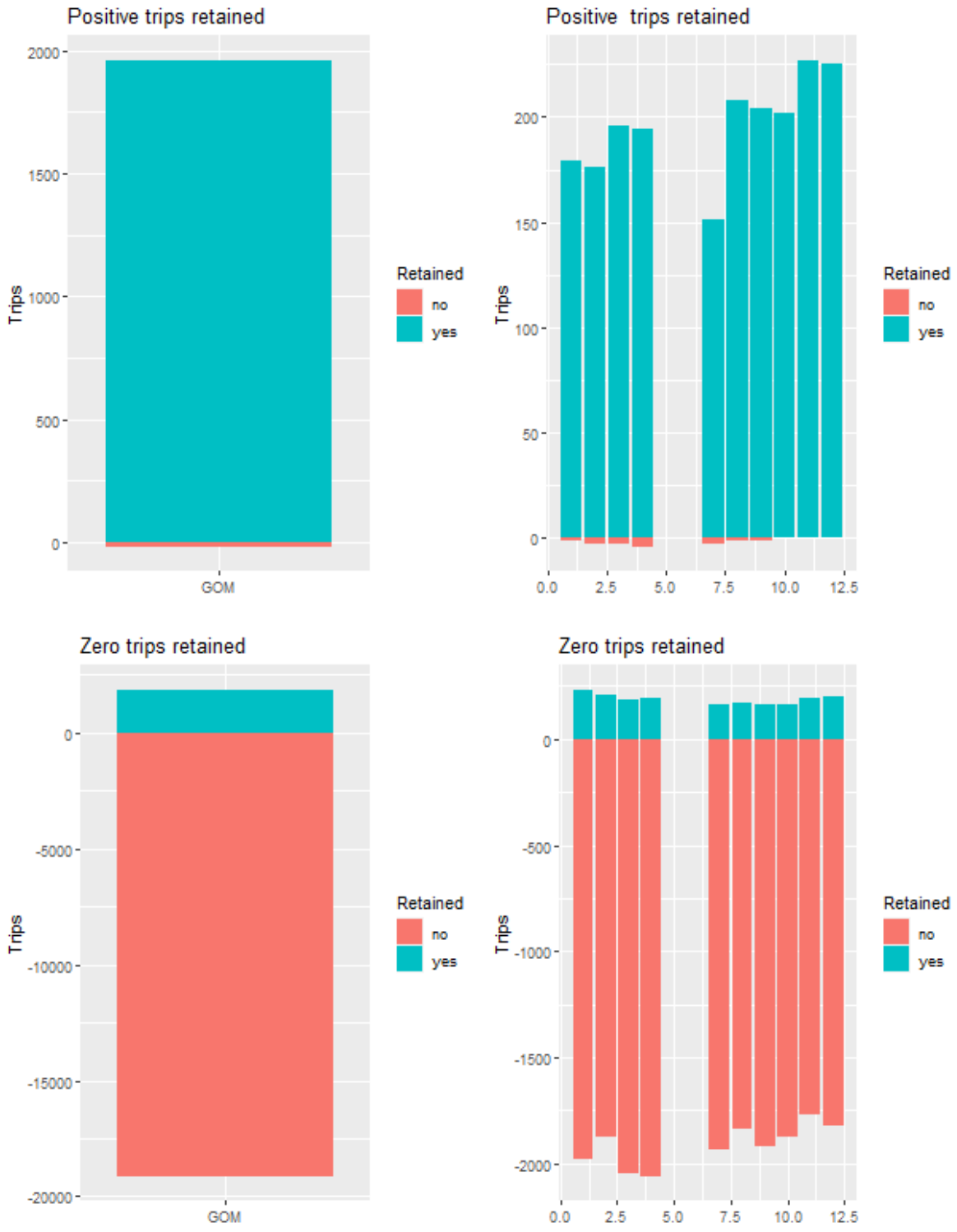


Figure 9. Positive and zero trips retained by region and month after subsetting using Stephens and MacCall approach (commercial longline).


Figure 10. Positive and zero trips retained by crew size and days at sea after subsetting using Stephens and MacCall approach (commercial longline).

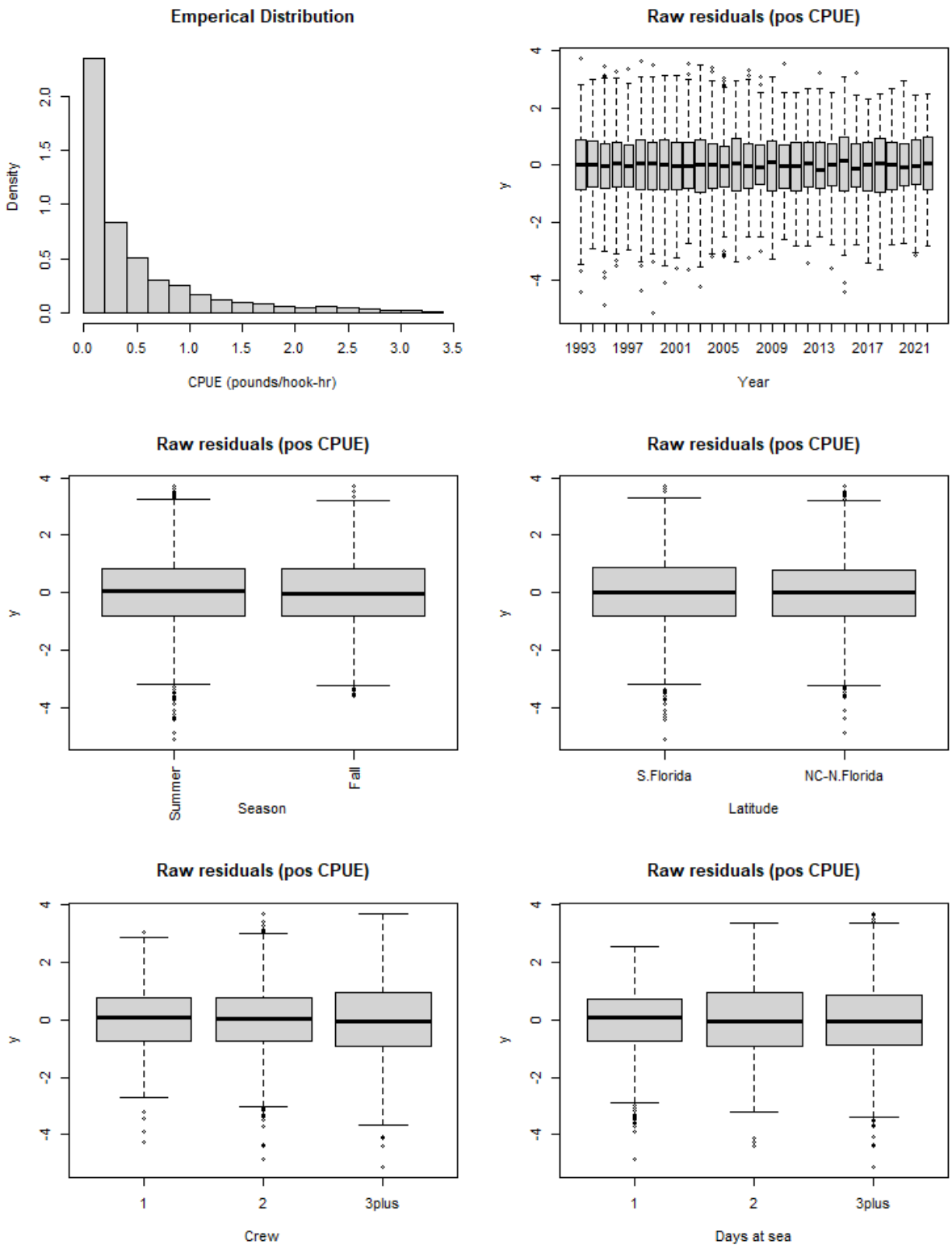


Figure 11. Handline index diagnostics of lognormal submodel fits to positive CPUE data. Top left panel shows the distribution of positive cpue. Box and whisker plots give first, second (median) and third quartiles, as well as limbs that extend to approximately one interquartile range beyond the nearest quartile, and outliers (circles) beyond the limbs. Residuals are raw.

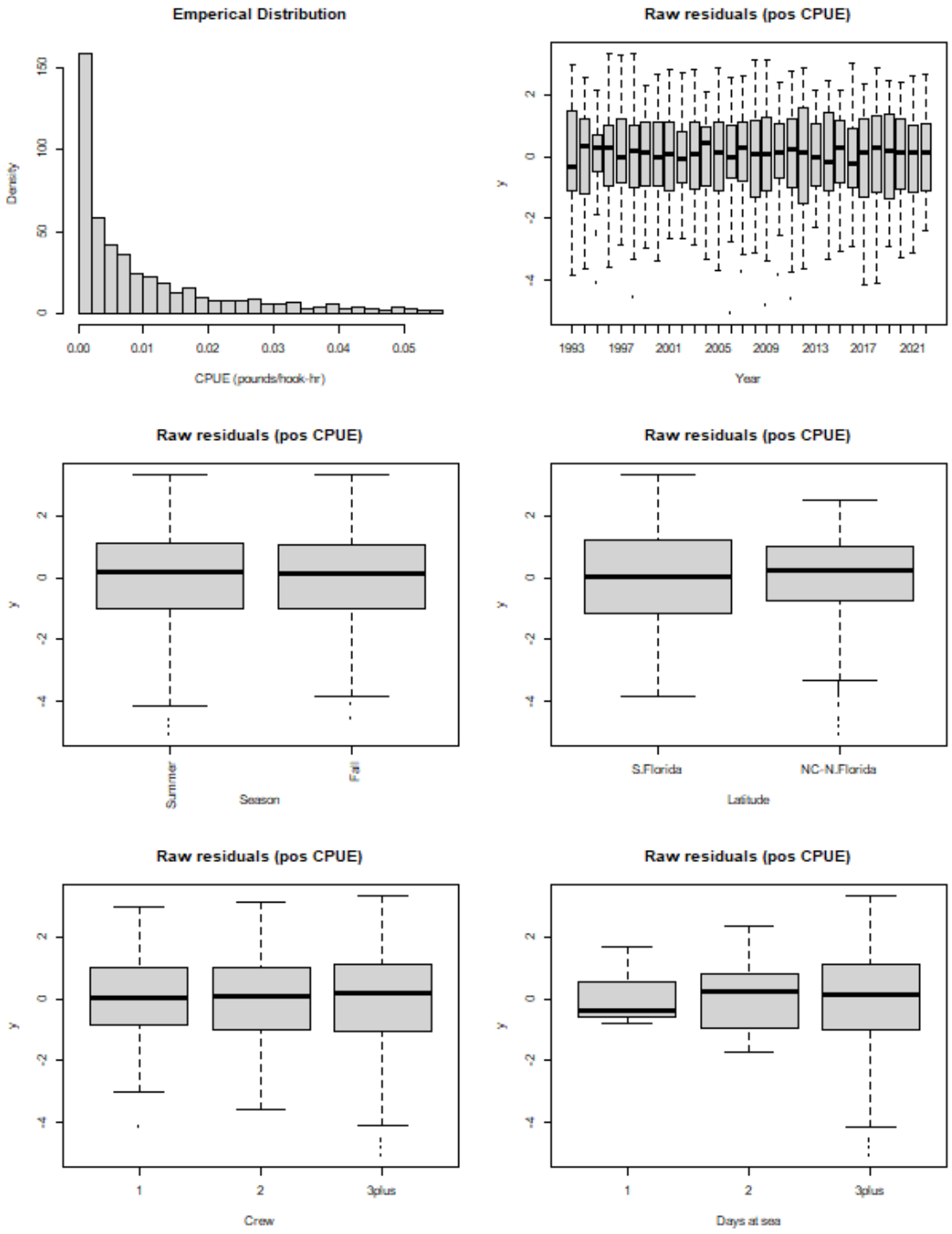


Figure 12. Longline index diagnostics of lognormal submodel fits to positive CPUE data. Top left panel shows the distribution of positive cpue. Box and whisker plots give first, second (median) and third quartiles, as well as limbs that extend to approximately one interquartile range beyond the nearest quartile, and outliers (circles) beyond the limbs. Residuals are raw.

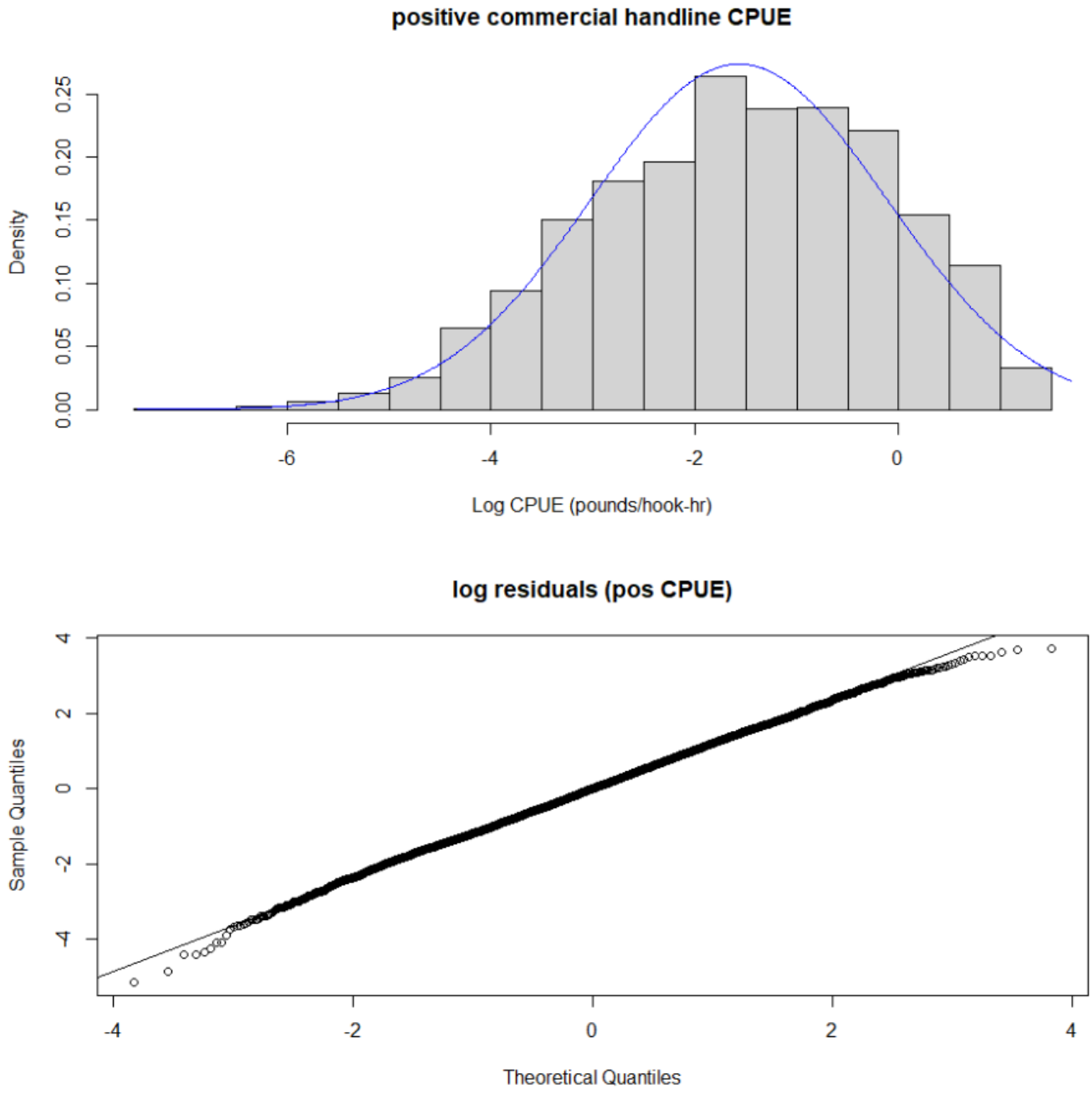


Figure 13. Histogram of empirical log CPUE, with the normal distribution overlaid. Quantile-quantile plot of residuals from the fitted lognormal submodel to the positive cpue catch (handline).

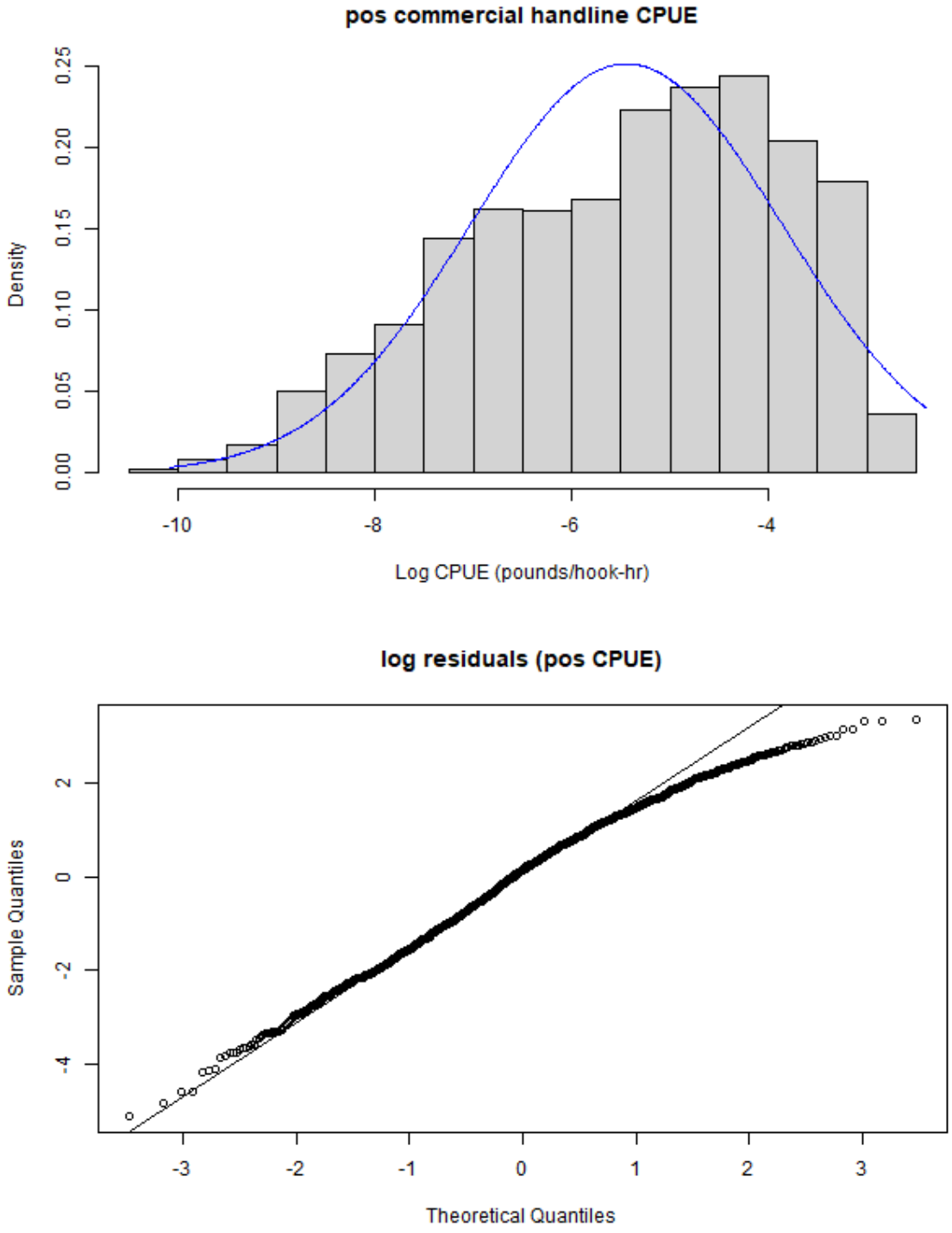


Figure 14. Histogram of empirical log CPUE, with the normal distribution overlaid. Quantile-quantile plot of residuals from the fitted lognormal submodel to the positive cpue catch (longline).

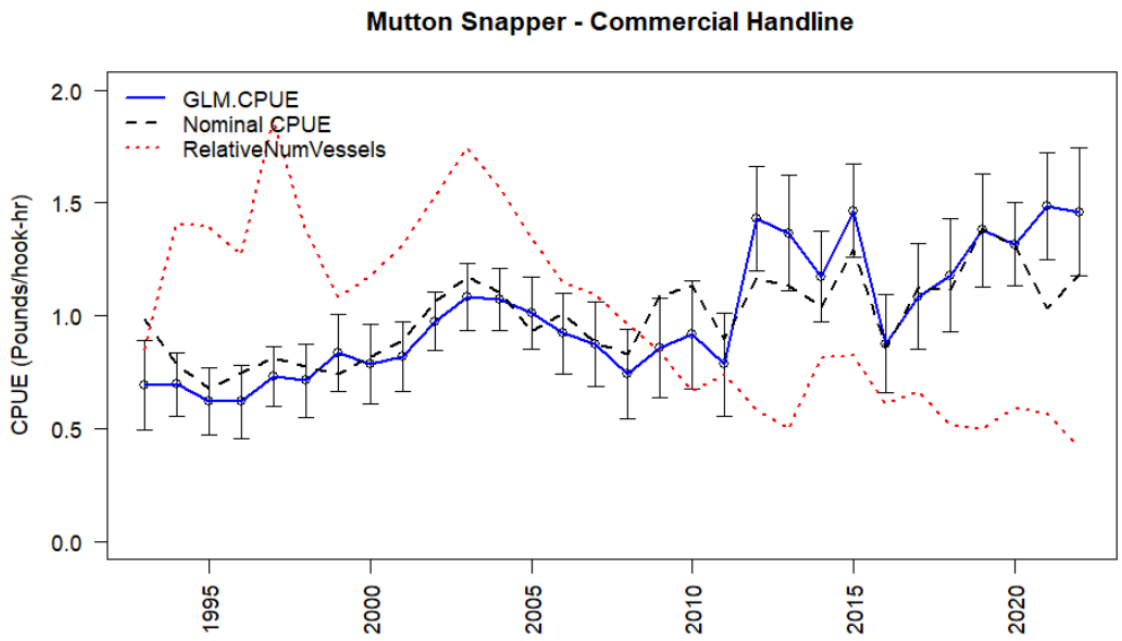


Figure 15. Preliminary standardized indices of abundance for mutton snapper commercial handline fleet with nominal index and relative number of vessels in the fishery by year.

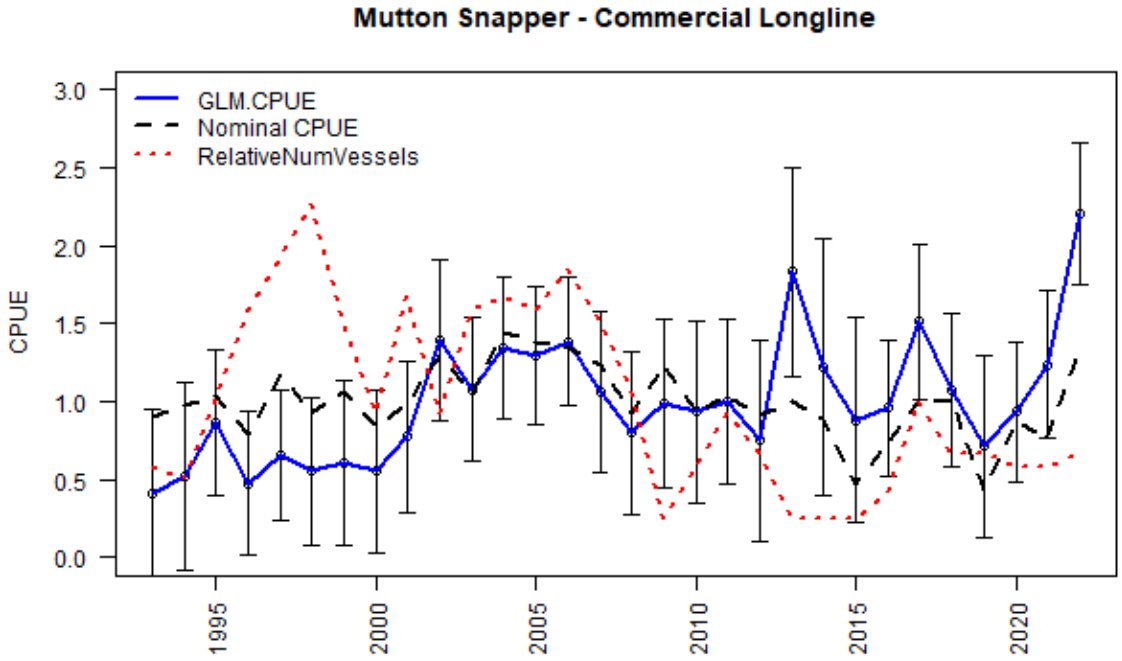


Figure 16. Preliminary standardized indices of abundance for mutton snapper commercial handline fleet with nominal index and relative number of vessels in the fishery by year.

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