Standardized catch rates of Yellowtail Snapper from the United States Gulf of Mexico and South Atlantic commercial handline fishery, 1993-2023

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SEDAR96-WP-04

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Standardized catch rates of Yellowtail Snapper from the United States Gulf of Mexico and South Atlantic commercial handline fishery, 1993-2023

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This document describes the development of the SEDAR 96 commercial logbook index for Yellowtail Snapper commercial handline fishery. Initial Yellowtail Snapper indices of abundance using the Commercial Fisheries Logbook Program data were constructed through 2010 during SEDAR 27A (SEDAR 27A-WP-01) and updated through 2018 for the SEDAR 64 assessment (SEDAR 64 Assessment Report).

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 fisheries, and since then has maintained the objective of a complete census of federally permitted vessels across the entire southeast U.S (Atkinson et al. 2021).

For each fishing trip, the CFLP records 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) includes number of lines fished, hours fished, and number of hooks per line.

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Background

For the SEDAR 64 Yellowtail Snapper assessment, two indices were constructed using the commercial logbook data for the handline fishery. A South Florida index which included landings and effort data from logbook statistical areas 1, 2, 3, 4, 2482, 2481, 2480, 2479, 2579, 2580, 2679, 2680, 2779, and 2780; and a core area index which included landings and effort data from logbook statistical areas 1, 2, 2482, 2481, 2480, 2579, 2580, 2679, and 2680. Only the South Florida index was used in the final assessment model in SEDAR 64 due to the increased sample sizes and subsequent lower CVs (SEDAR 2020). As such, this is the only index updated for this assessment and presented here. Areas included in the South Florida index are shown in Figure 1.

Data Description

Catch per unit effort (CPUE), defined as whole weight per hook hour, from the CFLP logbooks was used to develop an index of abundance for Yellowtail Snapper landed with handlines (manual handline and electric reel). Thus, the size and age range of fish included in the index is the same as that of landings from the commercial handline fleet.

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 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, closures)

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. Additionally, there were three closures of the Yellowtail Snapper season during the modeling time period (Fishery closed: 10/31/2015 – 12/31/2015; 6/3/2017 – 7/31/2017; 6/5/2018 – 7/31/2018). Any trips occurring during closure periods were excluded from analyses.

3. Areas included in the model

Following the methodology from SEDAR 64, only logbook data reported in the statistical areas mentioned above were included in the analyses for the south Florida index. Trips reported from areas outside of the defined region were excluded.

4. Time period

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. A terminal year of 2023 was used per the SEDAR 96 Terms of Reference. Some recent fisheries dependent indices have required a temporal truncation due to evidence of shifts in species associations (e.g. SEDAR 79 FL Mutton Snapper). An investigation into the stability of the Stephens and MacCall coefficients for this index found no evidence of shifts in associations, and therefore, no truncation was recommended.

Evaluation of explanatory variables

YEAR – Year was necessarily included, as standardized catch rates by year are the desired outcome. Years modeled were 1993-2023.

SEASON – Season included four levels: (Jan-Mar, Apr-Jun, Jul-Sep, Oct-Dec).

SUBREGION – Subregion included four levels: Southwest Florida (statistical areas 3, 4), Florida Keys (areas 1, 2, 748, 749), Southeast Florida (areas 736, 737, 740, 741, 744, 745) and Northeast Florida (areas 722, 723, 724, 727, 728, 729, 732, 733)

DAYS AT SEA – Days at sea (sea days) were pooled into two levels: one day (one), and two or more days (twoplus).

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 for handline trips

Subsetting trips

Effective effort was based on those trips from areas where Yellowtail 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.

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 Yellowtail Snapper in each trip to presence/absence of other species. A trip was then included if its associated probability of catching Yellowtail 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 Yellowtail 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. Gamma outperformed lognormal, and was therefore applied in the final delta-GLM. Diagnostics suggested a reasonable fit of the standardization procedure.

Results and Discussion

Stephens and MacCall results showed several species as strong predictors of Yellowtail Snapper presence, particularly species that showed strong negative correlations with Yellowtail Snapper such as Tilefish, grouper species and carangids (Fig. 2) The standardized index was similar to the nominal index and the diagnostic plots are shown in Figures 2 – 8. Residuals of the final model indicated no issues with the selected model variables in terms of skewed data or other patterns that would suggest poor model fits (Figures 7-8).

The final index showed a similar pattern to the nominal index (Fig. 9-10) with the general trend of increasing abundance through the time series that was similarly shown in SEDAR 64 with a dip in abundance in 2020 with the updated dataset. This is with a decreasing trend through time of trips indicating increased per trip landings of Yellowtail Snapper throughout the region during the time modeled (Fig. 9). Differences in the updated index compared to the one from SEDAR 64, particularly between 2006-2014 are likely a function of the updated data affecting the sub setting procedure with Stephens and MacCall and, to a lesser extent, updated the model to the more appropriate gamma distribution for the positive records rather than the previously used lognormal. Due to a lack of reported sample sizes in the SEDAR 64 report, it was impossible to determine the exact cause of the difference in fitted index values between SEDAR 64 and the current analysis. Final CVs of this index are shown in Table 1 and indicate that this is a well-fitted index to the time series with CV values in the range of 3-5% depending on year.

References

Atkinson, Sarina, Michael Judge, and Refik Orhun. 2021. Coastal Fisheries Logbook Program Metadata. SEDAR74-DW-3. SEDAR, North Charleston, SC. 17 pp.

Dick, E.J. 2004. "Beyond Lognormal Versus Gamma: Discrimination Among Error Distributions for Generalized Linear Models." *Fisheries Research* 70: 351–66.

Efron, B., and R. Tibshirani. 1993. *An Introduction to the Bootstrap*. London: Chapman; Hall.

Lo, N., L. Jacobson, and J. Squire. 1992. "Indices of Relative Abundance from Fish Spotter Data Based on Delta-Lognormal Models." *Canadian Journal of Fisheries and Aquatic Sciences* 49: 2515–26.

Maunder, M., and A. Punt. 2004. "Standardizing Catch and Effort Data: A Review of Recent Approaches." *Fisheries Research* 70: 141–59.

SEDAR. 2020. SEDAR 64 Stock Assessment Report Southeast Yellowtail Snapper. SEDAR, North Charleston, SC. 457 pp.

Shertzer, K. E., E. Williams, and J. Taylor. 2009. "Spatial Structure and Temporal Patterns in a Large Marine Ecosystem: Exploited Reef Fishes of the Southeast United States." *Fisheries Research* 100: 126–33.

Stephens, A., and A. MacCall. 2004. "A Multispecies Approach to Subsetting Logbook Data for Purposes of Estimating CPUE." *Fisheries Research* 70: 299–310.

Venables, W. N., and B. D. Ripley. 1997. *Modern Applied Statistics with s-Plus, 2nd Edition*. New York, New York: Springer-Verlag.

Table 1. Standardized index for the Yellowtail Snapper commercial handline fishery.

Year	N	Nominal CPUE	Relative nominal	Standardized CPUE	Proportion Positive	CV
1993	3914	4.939	0.613	0.650	0.873	0.040
1994	6384	4.558	0.566	0.603	0.853	0.036
1995	6000	4.315	0.536	0.553	0.849	0.038
1996	5248	3.722	0.462	0.418	0.798	0.039
1997	7450	4.198	0.521	0.530	0.808	0.036
1998	6833	4.925	0.611	0.561	0.773	0.036
1999	7009	5.617	0.697	0.712	0.811	0.037
2000	6140	4.995	0.620	0.580	0.790	0.038
2001	6195	5.885	0.730	0.643	0.786	0.036
2002	6246	5.649	0.701	0.635	0.778	0.036
2003	6140	5.232	0.649	0.588	0.779	0.038
2004	5293	6.248	0.776	0.702	0.785	0.039
2005	4935	6.634	0.823	0.833	0.831	0.037
2006	4426	7.442	0.924	0.886	0.843	0.037
2007	4305	7.537	0.936	0.866	0.832	0.039
2008	4318	8.653	1.074	1.045	0.821	0.038
2009	4269	8.324	1.033	0.987	0.818	0.039
2010	3245	9.537	1.184	1.104	0.837	0.040
2011	3118	8.458	1.050	1.015	0.817	0.042
2012	2993	8.837	1.097	1.063	0.820	0.040
2013	2573	9.131	1.133	1.183	0.808	0.043
2014	2993	9.018	1.119	1.138	0.788	0.040
2015	2931	9.876	1.226	1.344	0.814	0.040
2016	3533	10.995	1.365	1.484	0.811	0.038
2017	2353	13.329	1.655	1.909	0.854	0.039
2018	1865	11.699	1.452	1.636	0.860	0.044
2019	2105	11.931	1.481	1.447	0.796	0.047
2020	1395	9.471	1.176	1.077	0.769	0.051
2021	1532	10.969	1.362	1.293	0.814	0.049
2022	1556	13.829	1.717	1.689	0.843	0.046
2023	1490	13.785	1.711	1.826	0.897	0.045

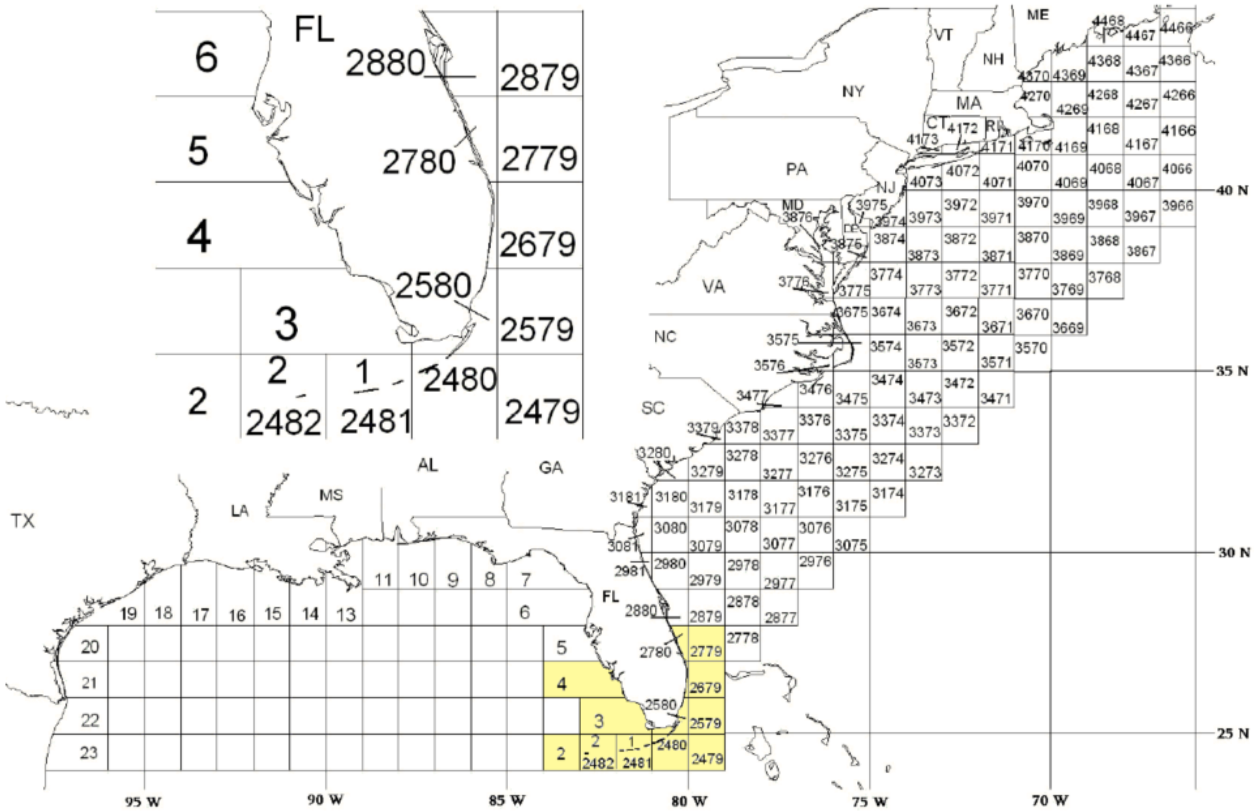


Figure 1. Map of statistical areas used in the South Florida CFLP Commercial Handline Index. Areas included are highlighted in yellow.

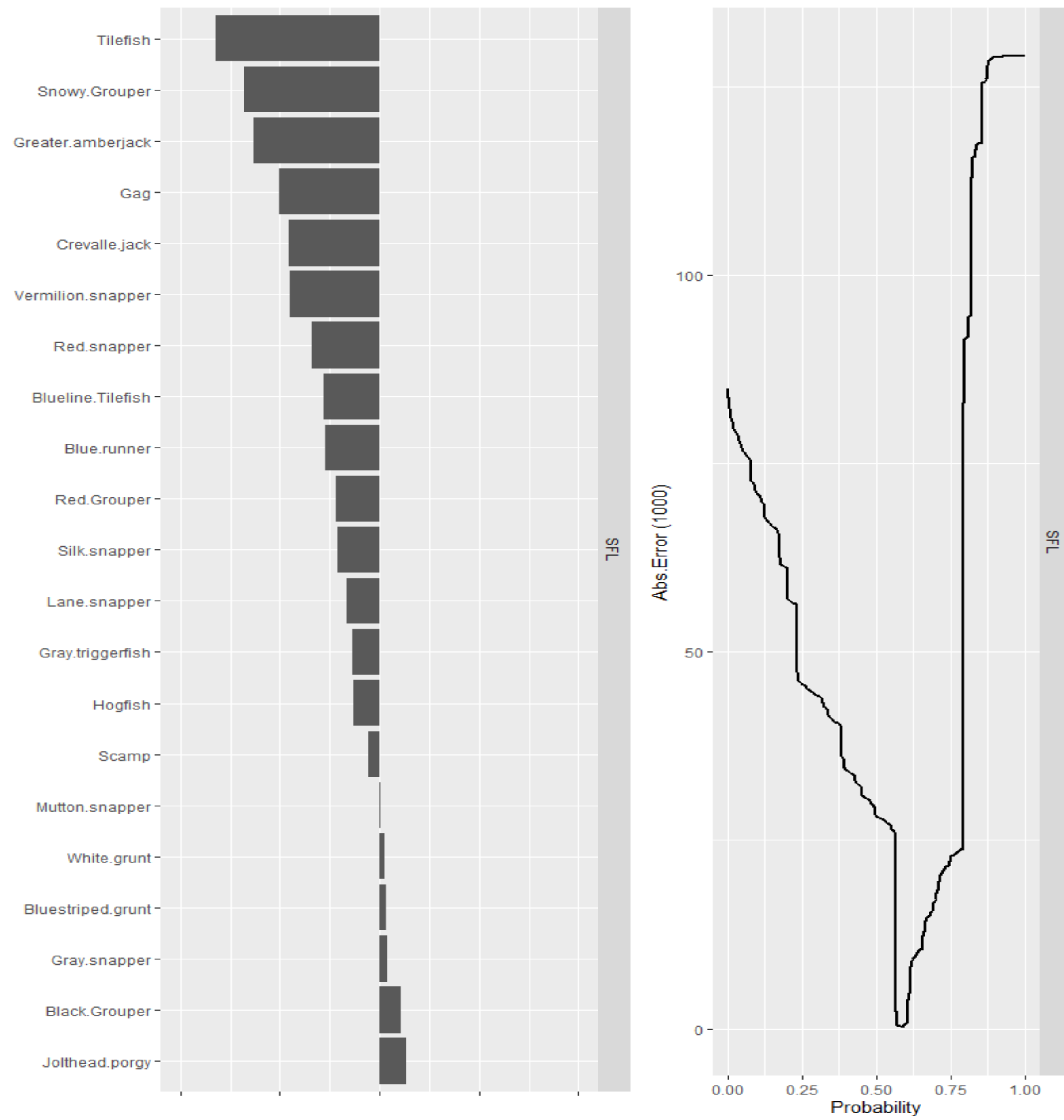


Figure 2. Estimates of species-specific regression coefficients used to predict each trip's probability of catching the focal species on the left panel. The right panel shows the absolute difference between observed and predicted number of positive trips across a range of probability cutoff values.

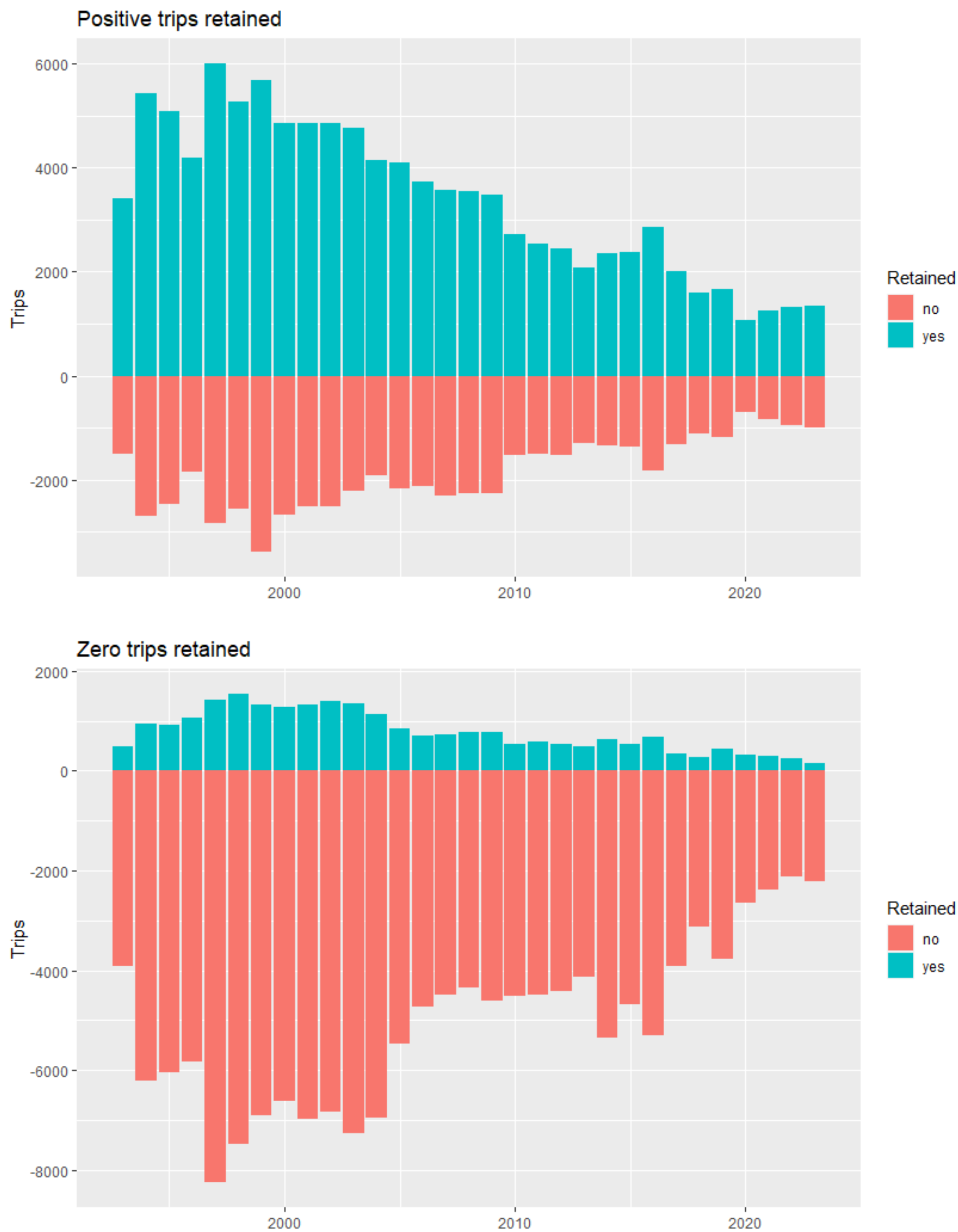


Figure 3. Commercial handline positive and zero trips retained after subsetting using Stephens and MacCall approach by year for Yellowtail Snapper.

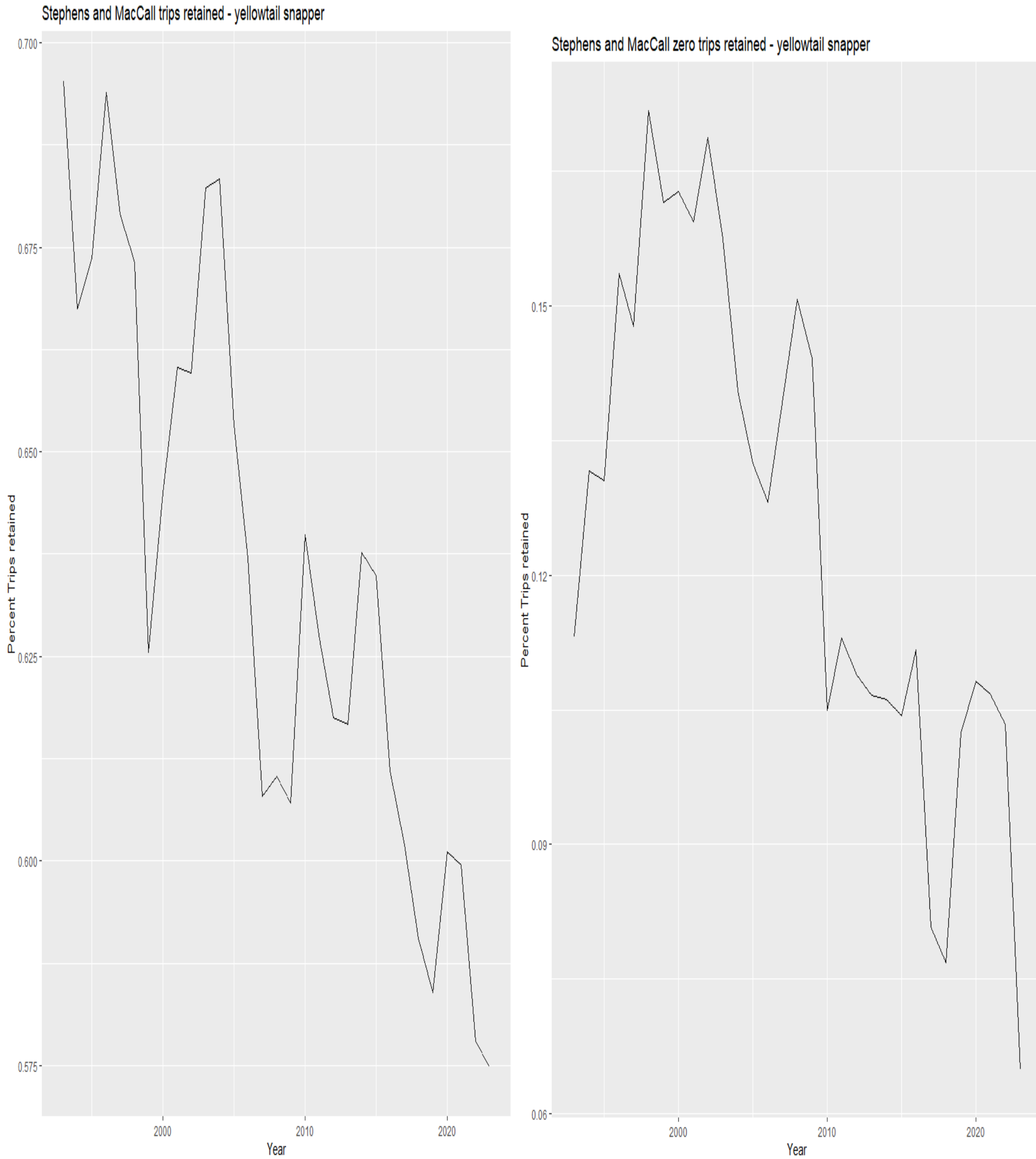


Figure 4. Proportion of positive (left) and zero (right) commercial handline trips retained by year after subsetting using Stephens and MacCall approach.

Figure 5. Positive and zero trips retained by subregion and month after subsetting using Stephens and MacCall approach.

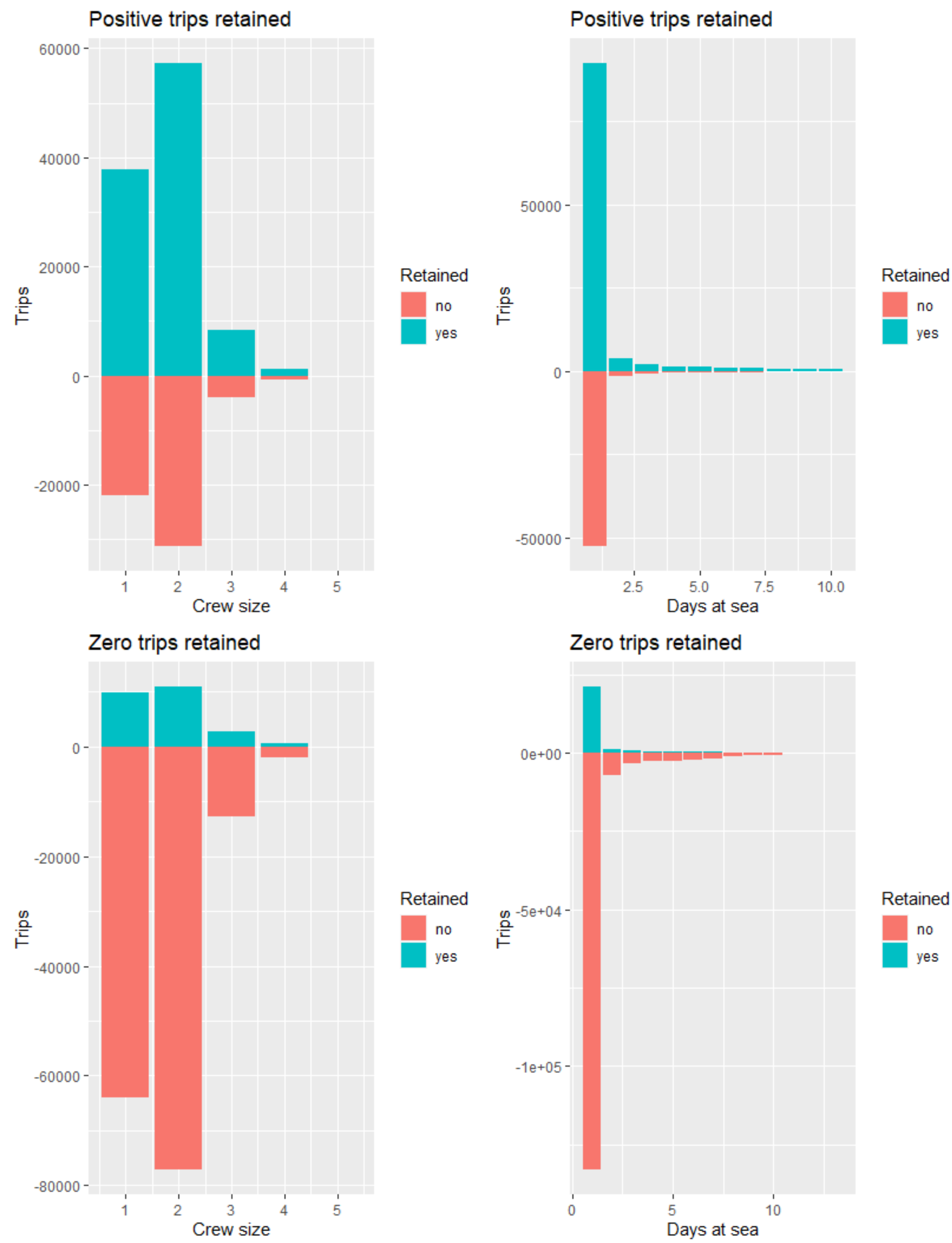


Figure 6. Positive and zero trips retained by crew size and days at sea after subsetting using Stephens and MacCall approach.

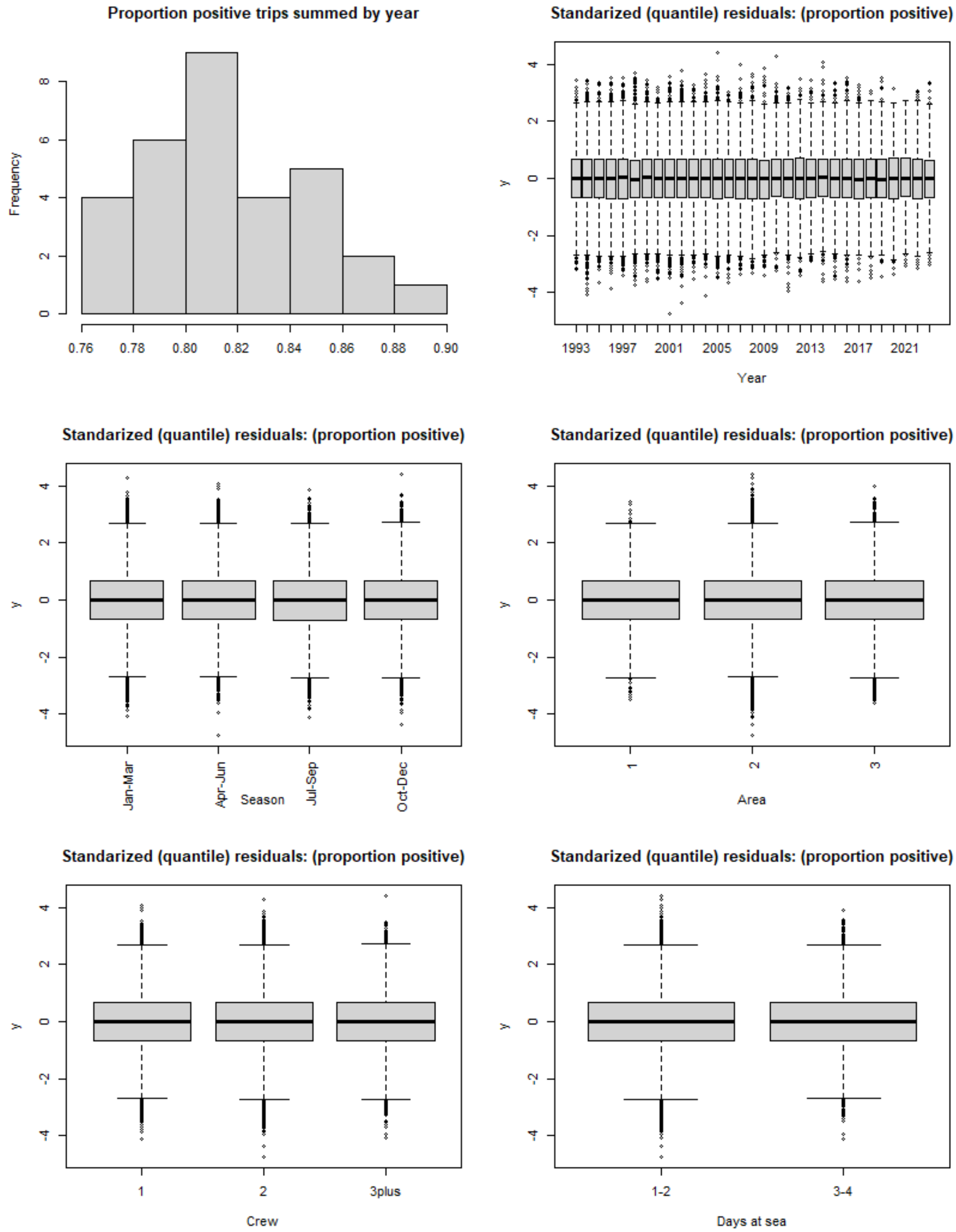
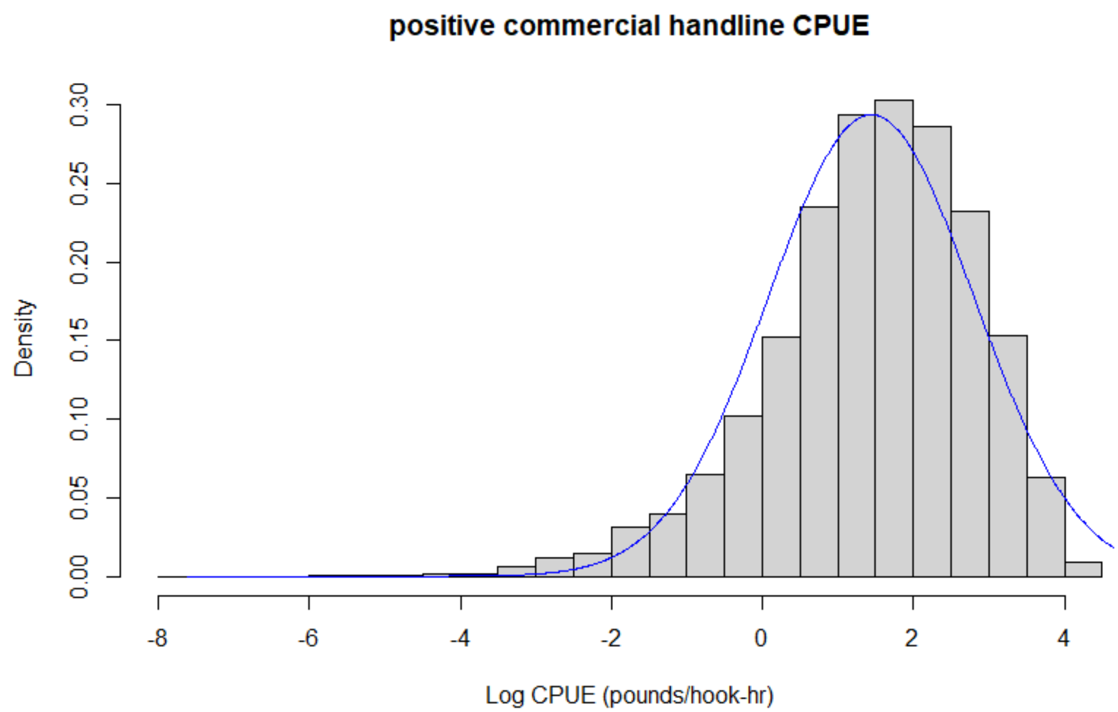


Figure 7. Handline index diagnostics of gamma submodel fits to positive CPUE data. Top left panel shows the distribution of positive cpue. Box and whisker plots give first, second (median) and third quartiles, as well as limbs that extend to approximately one interquartile range beyond the nearest quartile, and outliers (circles) beyond the limbs. Residuals are raw.



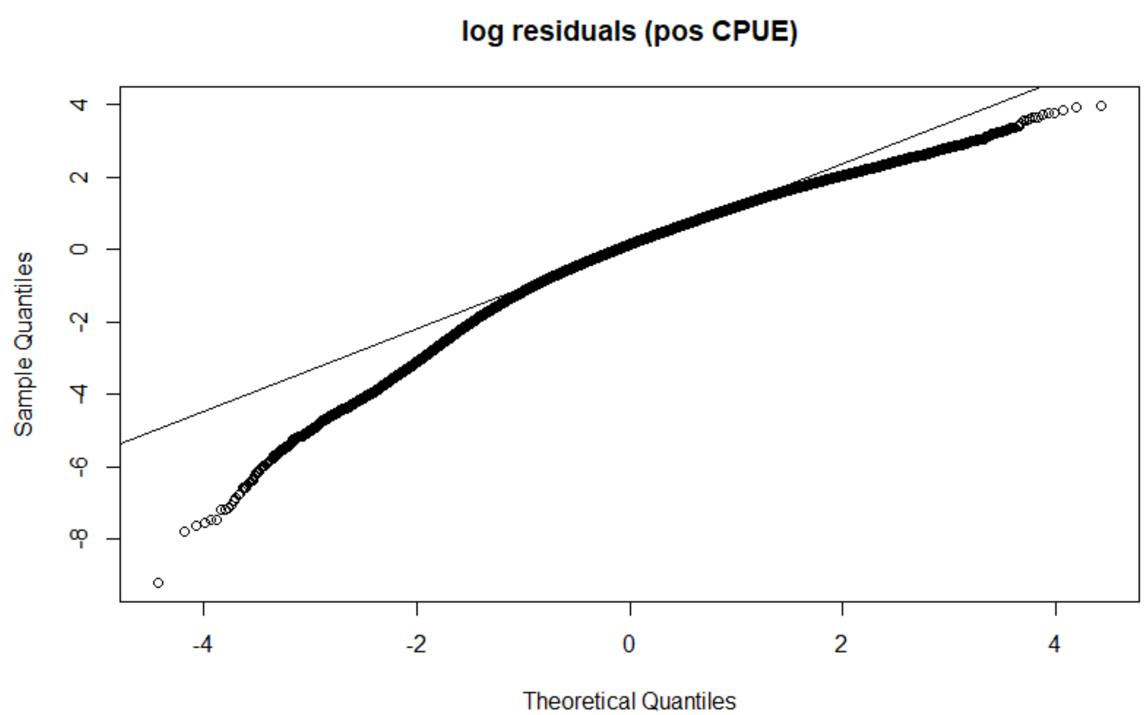


Figure 8. Histogram of empirical CPUE, with the gamma distribution overlaid. Quantile-quantile plot of residuals from the fitted gamma submodel to the positive cpue catch.

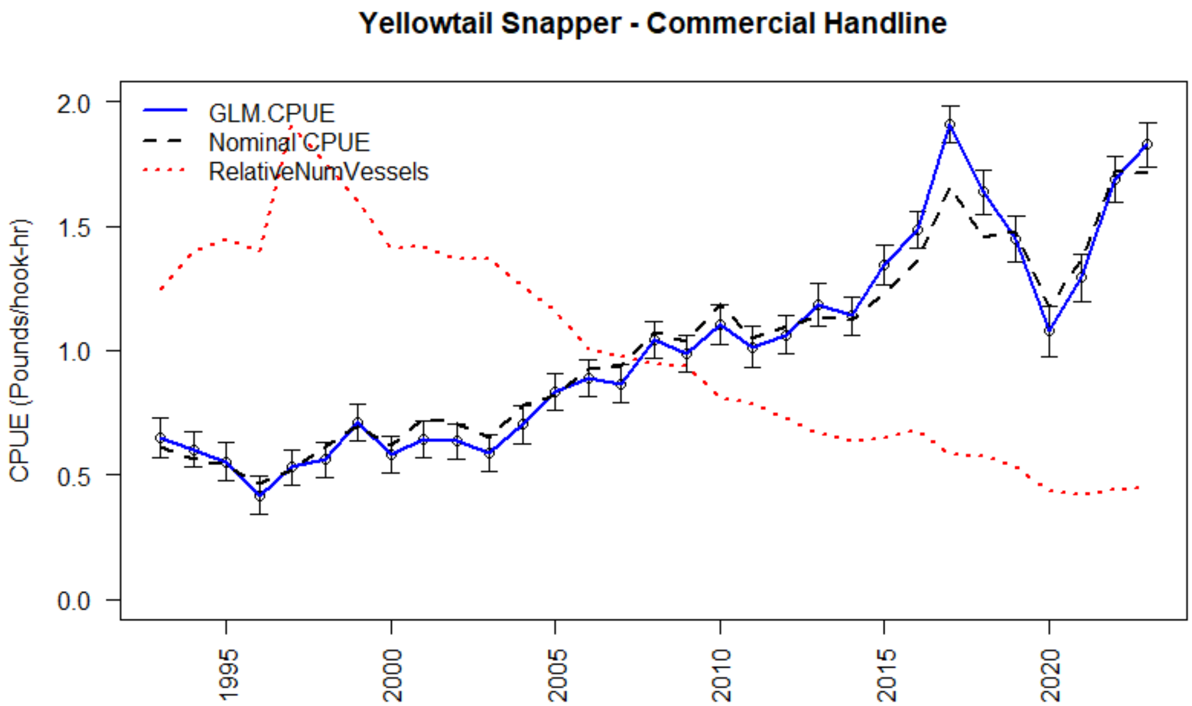


Figure 9. Standardized index of abundance for Yellowtail Snapper commercial handline fleet with nominal index and relative number of vessels in the fishery by year.

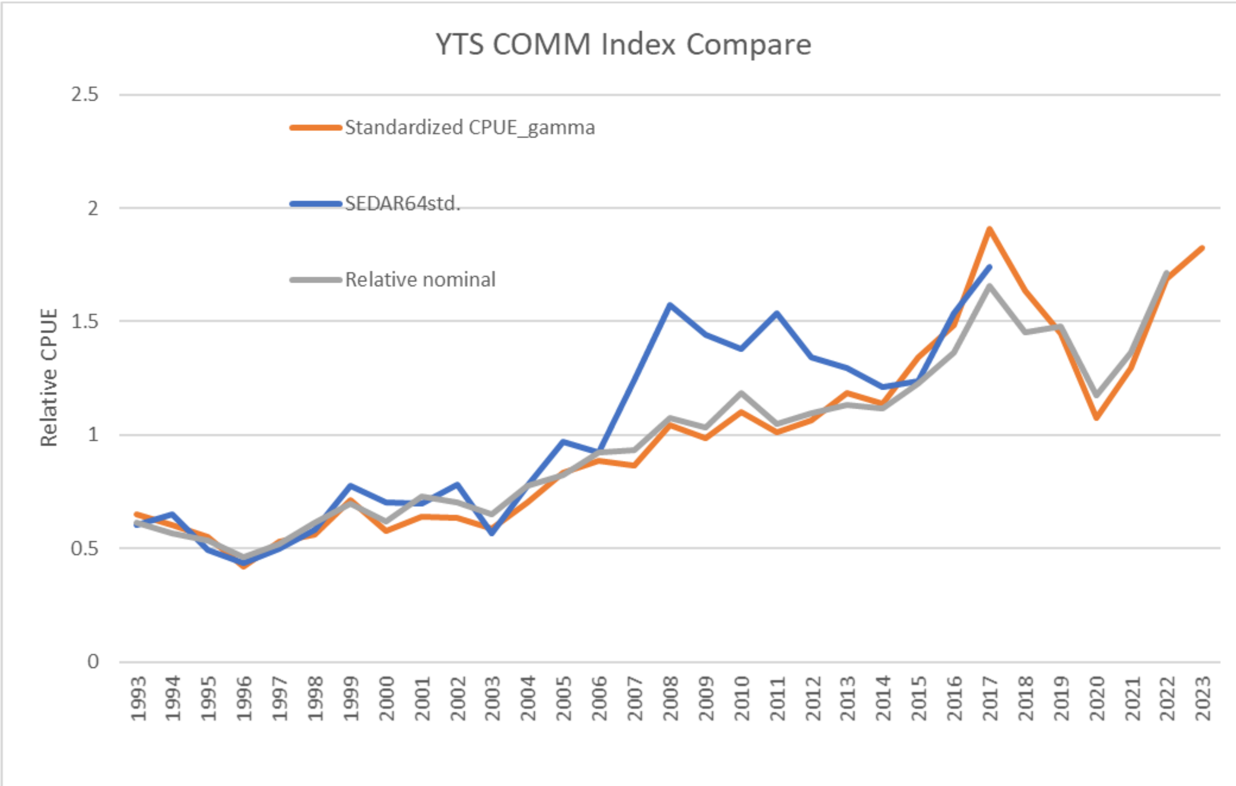


Figure 10. Comparison of SEDAR 96 Yellowtail Snapper commercial handline index (orange line) to the relative nominal CPUE (grey line) and the standardized index values reported in SEDAR 64 (blue line).